Herbert Chen
Editor

Illustrative Handbook of General Surgery

Springer

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Foreword

Learning surgery has become a daunting task. Although the basic surgical concepts remain durable and unchanged, the past several years have brought rapid growth of new knowledge in all of the surgical disciplines. Some surgical procedures have disappeared. Peptic ulcer disease and portal hypertension were once the source of a plethora of surgical interventions; now surgery is rarely necessary for either. New interventions have been developed. Gastric bypass for morbid obesity, once a rare procedure, has become one of the most commonly performed procedure. New technology has made operations less invasive but more complex and the knowledge requirements for new technology are very different than that required for conventional surgery.

The *Illustrated Handbook of General Surgery* has been created to allow medical students and residents learning surgery to assimilate, in a rapid and succinct manner, the anatomy and operative techniques associated with the most common surgical interventions. We are proud that all of the chapters have been edited and contributed by the faculty of the University of Wisconsin. The Department of Surgery at UW is comprised of almost 80 faculty, with nationally recognized expertise in every specialty. The essence of this text is its portability as well as its conciseness. Each chapter has been constructed so that critical, but not excessive, information is conveyed. Although a more extensive understanding of anatomy and operative technique will require consultation with a traditional surgical atlas, the information conveyed in this text is portable (able to be kept in the pocket of a white coat) and sufficient to allow the student or resident to gain a basic understanding of the anatomy and technique of most surgical procedures. I am certain that you will find this text to be extraordinarily useful and anticipate that it will facilitate rapid growth of your surgical knowledge.

Madison, Wisconsin K. Craig Kent

Preface

With the large number of surgical atlases in the market focusing on a variety of surgical procedures, it is almost impossible to find an area that is not comprehensively illustrated. However, almost all of these atlases are very large and serve to be “library” or “office” books, which are commonly cumbersome to transport and not readily available in the operating room. In the complex training scheme that surgical residents often encounter, they may perform a variety of surgical procedures in any given day. Furthermore, medical students doing rotations are often exposed to a variety of operations within the same time period. It is very difficult for students, residents, and even attending surgeons to go back to their office and look at a surgical atlas prior to each and every operation.

Thus, it would be much more practical to have an atlas that can be carried in the clinical jacket and be referred to immediately prior to the operation to refresh one’s memory. The *Illustrated Handbook of General Surgery* was created to serve this purpose: to allow students and residents to be well prepared before going into the operating room. This portable surgical atlas includes chapters covering the anatomy and operations of the thyroid, parathyroid, adrenal, breast, stomach, esophagus, small bowel, colon, rectum, liver, pancreas, gallbladder, and hernias.

The chapters of *Illustrated Handbook of General Surgery* are edited by the general surgery faculty of the University of Wisconsin who practice at the University of Wisconsin Hospital and Clinics. In addition, several surgeons from other prominent surgical departments around the world were invited to contribute. The detailed text and pictures are designed to provide a brief but comprehensive summary of each operation, which should facilitate further learning by medical students and residents in the operating room.

Madison, Wisconsin Herbert Chen

Contents

Part I Endocrine Surgery
Rebecca S. Sippel

1 **Total Thyroidectomy and Thyroid Lobectomy** 3
Insoo Suh and Wen T. Shen

2 **Central Neck Dissection** 11
Dina M. Elaraj and Cord Sturgeon

3 **Modified Radical Neck Dissection** 17
Cord Sturgeon and Dina M. Elaraj

4 **Parathyroidectomy** 23
Lilah F. Morris and Michael W. Yeh

5 **Open Adrenalectomy** 29
Raul Alvarado, Goswin Y. Meyer-Rochow and Stan B. Sidhu

6 **Laparoscopic Adrenalectomy** 37
Shamly V. Dhiman and James A. Lee

Part II Breast Surgery
Michael P. Sloan

7 **Breast Biopsy** 47
Michael P. Sloan and Catherine Beckman

8 **Breast Procedures** 53
Michael P. Sloan and Catherine Beckman

9 **Axillary Procedures** 57
Michael P. Sloan and Catherine Beckman

Part III Esophageal and Gastric Surgery
Jon Gould

10 **Laparoscopic Nissen Fundoplication** 63
Jon Gould

11 Laparoscopic Paraesophageal Hernia Repair 73
Jon Gould

12 Minimally Invasive Surgical Treatment of Achalasia 81
Sandeepa Musunuru and Jon Gould

13 Laparoscopic Roux-en-Y Gastric Bypass 89
Anna Ibele, Gretchen Beverstein, and Jon Gould

14 Esophagectomy 99
James D. Maloney and Tracey L. Weigel

15 Gastric Resection 109
Anna Ibele and Jon Gould

Part IV Small Bowel and Appendix Surgery
Peter F. Nichol

16 Small Bowel Resection 127
Pablo Laje and Peter F. Nichol

17 Meckel's Diverticulum Resection 135
Peter Mattei

18 Appendectomy 139
Ari Reichstein and Peter F. Nichol

Part V Colorectal Surgery
Charles P. Heise

19 Right Hemicolectomy 149
Matthew C. Koopmann and Charles P. Heise

20 Sigmoid Colectomy 159
Matthew C. Koopmann and Charles P. Heise

21 Low Anterior Resection and Abdominoperineal Resection 167
Erik E. Johnson and Charles P. Heise

22 Stomas (Colostomy and Ileostomy) 179
Erik E. Johnson and Charles P. Heise

Part VI Anorectal Surgery
Gregory D. Kennedy

23 Lateral Internal Sphincterotomy 189
Pasithorn A. Suwanabol and Gregory D. Kennedy

24 Cryptoglandular Disease 195
Erin S. O'Connor and Gregory D. Kennedy

25 Pilonidal Operations 207
Marie K. Stelzer and Gregory D. Kennedy

26 Hemorrhoids 217
Carter T. Smith and Gregory D. Kennedy

Part VII Hernia Surgery
David M. Melnick

27 Abdominal Wall Hernias: Introduction 227
David M. Melnick and Jacquelynn D. Arbuckle

28 Inguinal Herniorrhaphy 229
David M. Melnick and Jacquelynn D. Arbuckle

29 Totally Extraperitoneal Preperitoneal Laparoscopic Inguinal Hernia Repair 235
David M. Melnick and Jacquelynn D. Arbuckle

30 Incisional Hernia 239
David M. Melnick and Jacquelynn D. Arbuckle

31 Umbilical Hernia 243
David M. Melnick and Jacquelynn D. Arbuckle

Part VIII Hepatobiliary Surgery
Clifford S. Cho

32 Hepatic Procedures 249
Andrew J. Russ and Clifford S. Cho

33 Biliary Procedures 279
Andrew J. Russ and Clifford S. Cho

34 Laparoscopic Splenectomy 293
Andrew J. Russ and Clifford S. Cho

Part IX Pancreatic Surgery
Sharon M. Weber

35 Pancreaticoduodenectomy (Whipple Procedure) 299
Scott N. Pinchot and Sharon M. Weber

36 Distal Pancreatectomy 311
Nicholas A. Hamilton and William G. Hawkins

37 Surgical Treatment of Chronic Pancreatitis 321
Matthew R. Porembka, William G. Hawkins, and Steven M. Strasberg

Index 333

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Part I
Endocrine Surgery

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Chapter 1
Total Thyroidectomy and Thyroid Lobectomy

Insoo Suh and Wen T. Shen

1.1 Indications

The indications for thyroidectomy encompass a wide spectrum of thyroid disorders, but the majority fall under three categories:

1) Hyperthyroidism or thyroiditis refractory to nonsurgical management [1, 2],
2) Goiters with or without local compressive symptoms [3, 4], and
3) Thyroid nodules and cancers [5].

The decision to perform a total thyroidectomy versus a more limited resection (e.g., unilateral lobectomy) depends on the underlying disease, on the patient's clinical profile, and in some instances on surgeon's or patient's preference.

1.2 Preoperative Preparation

All patients undergoing thyroidectomy should have preoperative biochemical thyroid function tests as well as a neck ultrasound with fine-needle aspiration biopsies of suspicious nodules [6]. Depending on the type and extent of disease, selected patients may require further imaging studies such as CT, MRI, scintigraphy, and endoscopy [7]. Patients should ideally be euthyroid at the time of operation, with either antithyroid medication or Lugol's solution for hyperthyroidism or exogenous thyroid hormone supplementation for hypothyroidism.

Direct laryngoscopy must be performed on any patient with hoarseness or a prior history of neck operations in order to assess preoperative vocal cord function. Pre-anesthetic evaluation should be a routine step prior to any procedure requiring general anesthesia.

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1.3 Positioning and Anesthesia

Most thyroidectomies are performed under general anesthesia with endotracheal intubation. The patient is placed supine in a 20º reverse Trendelenburg position, with both arms tucked. The neck is hyperextended by placing a beanbag or soft roll behind the scapulae and a foam ring under the head. This places the thyroid in a more anterior position. The head must be well supported to prevent postoperative posterior neck pain. The surgical area is prepared with 1% iodine or chlorhexidine and sterilely draped. We routinely perform our own ultrasound prior to surgical prep in order to assess the anatomy and facilitate operative planning.

1.4 Description of Procedure

In general, thyroid operations should be performed in a bloodless field so that vital structures can be identified. Bleeding obscures the normal color of the parathyroids and recurrent laryngeal nerve (RLN), placing these important structures at greater risk for injury. If bleeding does occur, pressure should be applied; vessels should be clamped only if they are precisely identified or shown to not be in close proximity to the RLN.

A centrally placed, 4–6 cm Kocher transverse incision is made 1 cm caudad to the cricoid cartilage, paralleling the normal skin lines of the neck (Fig. 1.1). The incision is extended through the platysma, at which point subplatysmal flaps are raised, first cephalad to the level of the thyroid cartilage and then caudad to the suprasternal notch. Five straight Kelly clamps placed on the dermis of each flap aid in retraction for this dissection.

Fig. 1.1 Skin incision. The pen marks, from top to bottom, denote the thyroid cartilage, cricoid cartilage, and suprasternal notch, respectively. A centrally placed, 4–6 cm Kocher transverse incision is made 1 cm caudad to the cricoid cartilage, paralleling the normal skin lines of the neck (*white dotted line*)

In a cancer operation, dissection of the thyroid gland is generally begun on the side of the suspected tumor, since a problem with the dissection on this side could lead the surgeon to perform a less-than-total thyroidectomy on the contralateral side in order to avoid complications. One exception is the large bulky tumor, in which case the surgeon sometimes dissects the contralateral side first in order to more easily mobilize the thyroid gland.

The strap muscles are separated in the midline via an incision through the superficial layer of the deep cervical fascia starting at the suprasternal notch and extending cephalad to the thyroid cartilage. On the side of the suspected tumor, the more superficial sternohyoid is separated from the deeper sternothyroid muscle by blunt dissection, proceeding laterally until the ansa cervicalis is visible at the lateral border of the sternothyroid muscle. The sternothyroid muscle is then dissected from the underlying thyroid capsule until the middle thyroid vein is encountered laterally. The thyroid is retracted anteromedially and the carotid sheath and strap muscles are retracted laterally. A peanut sponge can be used to facilitate retraction and exposure of the area posterolateral to the thyroid. The middle thyroid vein is optimally exposed for division at this time (Fig. 1.2).

In the case of thyroid lobectomy, the isthmus is usually divided early in the dissection to facilitate mobilization. The isthmus is clamped and divided lateral to the midline, taking care to not leave residual tissue anterior to the trachea to minimize the chances of hypertrophy of the thyroid remnant. The LigaSure or harmonic scalpel coagulation devices are useful for dividing the thyroid parenchyma in a hemostatic manner; alternatively, the isthmus can be divided with a scalpel between clamps and the thyroid remnant oversewn at the cut edge.

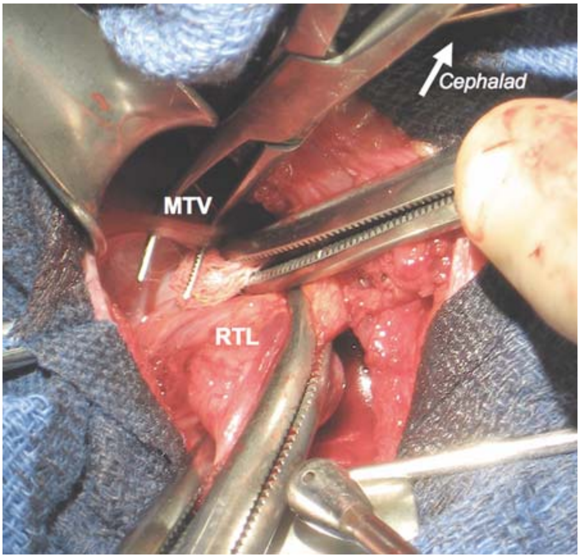

Fig. 1.2 Identification of the middle thyroid vein (MTV). On this side, the right thyroid lobe (RTL) is retracted anteromedially to expose the MTV, which is isolated in preparation for division and ligation

The superior pole is dissected mostly in a blunt fashion with a small peanut sponge on a clamp. The dissection is carried out superolaterally and posteriorly, with counter-traction of the thyroid inferomedially. This exposes the superior thyroid vessels as well as some connective tissue lateral to the superior pole. These tissues are carefully mobilized below the level of the cricothyroid muscle, since the RLN passes through Berry's ligament and enters the cricothyroid muscle at the level of the cricoid cartilage. The superior pole vessels are individually skeletonized, double- or triple-clamped, and ligated (Fig. 1.3). They are then divided close to the surface of the thyroid in order to prevent injury to the external branch of the superior laryngeal nerve as it traverses the anterior surface of the cricothyroid muscle. Division of these vessels allows for easy sweeping of the remaining filmy tissues away from the posterior aspect of the superior pole via blunt dissection. The superior parathyroid gland is often identified behind the superior pole during this dissection, at the level of the cricoid cartilage. It is usually located close to a small posterolateral protuberance of the thyroid lobe known as the tubercle of Zuckerkandl, and as a general rule is located posterolateral to the RLN (Fig. 1.4).

The mobilization of the lateral and inferior aspects of the thyroid lobe includes the definitive identification of the inferior parathyroid gland and RLN. With the thyroid lobe retracted anteromedially and the carotid sheath laterally, dissection should proceed cephalad along the lateral edge of the thyroid. Fatty and lymphatic tissues immediately adjacent to the thyroid are swept laterally with a peanut sponge and small vessels are ligated with clips. The inferior parathyroid and RLN are usually encountered during this lateral mobilization, and care must be taken not to transect any tissues in this area until these vital structures are identified. The location of the inferior parathyroid gland is less constant than that of the superior gland, but

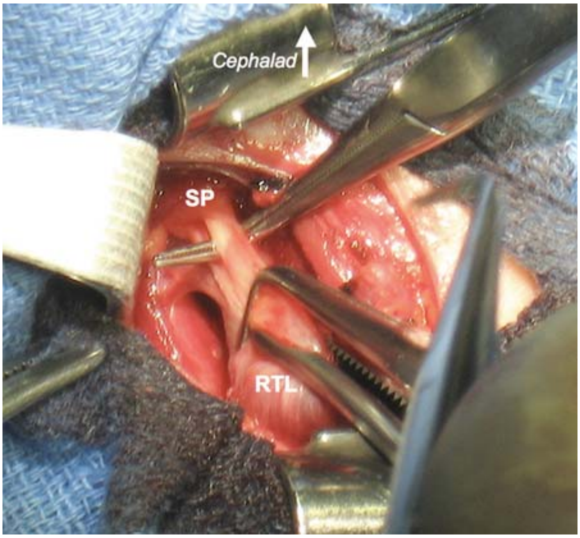

Fig. 1.3 Dissection of the superior pole (SP). In the image, counter-traction of the right thyroid lobe (RTL) inferomedially exposes the SP vessels, which are individually skeletonized, clamped, and ligated

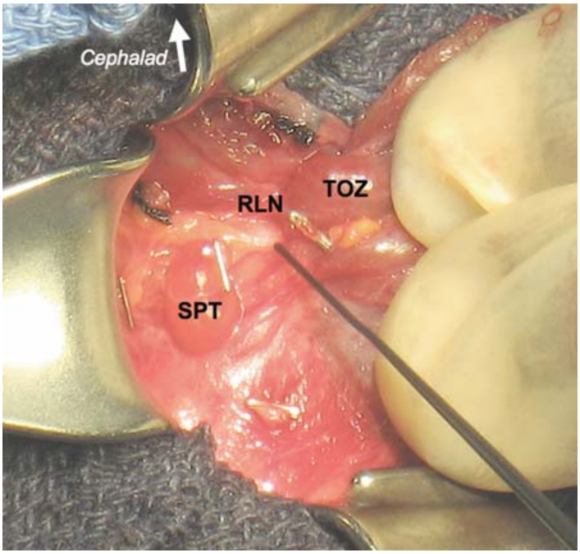

Fig. 1.4 Identification of the superior parathyroid gland (SPT) and recurrent laryngeal nerve (RLN). The SPT is usually posterolateral to the RLN (shown here with the nerve monitoring probe), at the level of the cricoid cartilage. The right thyroid lobe, including the tubercle of Zuckerkandl (TOZ), is retracted medially for optimal exposure of the RLN

it is usually located anterior to the RLN and inferior to the inferior thyroid artery as it crosses the RLN (Fig. 1.5). All normal parathyroid glands should be carefully swept away from the thyroid on as broad a vascular pedicle as possible to prevent devascularization, since this would necessitate autotransplantation of the gland. The course of the right and left RLN can vary considerably. The left RLN is usually situated more medially, running in the tracheoesophageal groove, while the right RLN

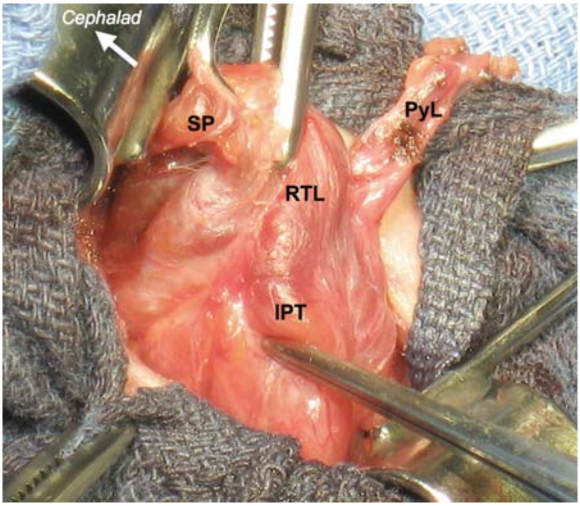

Fig. 1.5 Identification of the inferior parathyroid (IPT). After the superior pole (SP) has been dissected and mobilized, the right thyroid lobe (RTL) is retracted superomedially to begin the inferior pole dissection. The IPT is often variable in position, but is usually anterior to the recurrent laryngeal nerve. Note also the pyramidal lobe (PyL), which in this case was mobilized prior to the RTL dissection

takes a more oblique course and may pass either anterior or posterior to the inferior thyroid artery.

The pyramidal lobe, present in 80% of patients, is mobilized prior to resection (Fig. 1.5). The pyramidal lobe extends in a cephalad direction and can reach the level of the hyoid bone. It is mobilized by retracting it caudally and dissecting away adjacent tissues on either side, proceeding cephalad until it becomes a thin fibrous band. Once the parathyroids and RLN are identified and preserved, the remainder of the thyroid lobe is easily dissected off the trachea and resected. The same steps apply for the other side in the case of a total thyroidectomy. After meticulous hemostasis, the sternothyroid and sternohyoid muscles are re-approximated with 4-0 absorbable sutures, with a small opening left in the midline at the suprasternal notch to allow any blood to exit. The platysma layer is approximated with similar sutures and the skin is closed with either butterfly clips or a subcuticular suture.

1.5 Postoperative Care

Though relatively uncommon in experienced centers, significant complications can occur after thyroidectomy, including RLN injury, hypoparathyroidism, bleeding leading to life-threatening airway compromise, injury to the external branch of the superior laryngeal nerve, infection, seroma, and keloid formation. Because of the small but serious risk of neck hematoma, postoperative patients are usually admitted overnight to the hospital ward for observation. They are positioned in a low Fowler position with the head and shoulders elevated 10º–20º for the first 6–12 postoperative hours, in order to maintain negative pressure in the veins. Eating is resumed within 4 h. For patients who have undergone bilateral exploration, serum calcium levels are measured 6 h after operation and again the next morning; a serum phosphorus level is also measured at a latter time point. Patients who have undergone unilateral first-time exploration do not require biochemical evaluation. Oral calcium supplements are administered for signs of biochemical and/or symptomatic hypocalcemia.

The vast majority of patients are discharged on the first postoperative day; they are given a prescription for thyroid hormone supplementation if the procedure was more extensive than a lobectomy and are instructed to take calcium tablets for symptoms of hypocalcemia. Most patients can return to work or full activity within 1 week. They are seen in the outpatient clinic within 2 weeks after discharge, at which time further management is discussed in light of the pathology findings as well as the results of any relevant follow-up laboratory evaluation.

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Chapter 2
Central Neck Dissection

Dina M. Elaraj and Cord Sturgeon

2.1 Indications

Lymph nodes in the neck are classified by their location (Levels I–VI). Level VI, also known as the central compartment of the neck, is bounded by the carotid arteries laterally, the hyoid bone superiorly, and the suprasternal notch inferiorly [1]. It contains the Delphian (precricoid), pretracheal, and paratracheal lymph nodes. Level VII nodes, although not technically located in the neck, are often included when describing lymph node groups/levels in the neck. They are located in the superior mediastinum between the suprasternal notch and brachiocephalic vessels, and lymph nodes in Level VII can be resected en bloc with those in Level VI.

Thyroid cancer is classified by cell of origin. Differentiated thyroid cancers of follicular cell origin include papillary, follicular, and Hürthle cell cancers. Medullary thyroid cancer is derived from the calcitonin-producing parafollicular cells and has a different biology than cancers of follicular cell origin. Eighty percent of thyroid cancers are of the papillary subtype, which first metastasize to the cervical lymph nodes [2]. Medullary thyroid cancer also tends to first metastasize to the cervical lymph nodes [3]. Follicular and Hürthle cell cancers have a propensity for hematogenous metastases and rarely spread to cervical lymph nodes.

Lymph node metastases from papillary and medullary thyroid cancers are very common and they have been observed to have an adverse impact on prognosis, with the possible exception of patients with papillary thyroid cancer who are younger than 45 years [4]. Cervical nodal metastases usually occur in a stepwise fashion, first involving lymph nodes of the ipsilateral central neck, then involving lymph nodes of the ipsilateral lateral neck (Levels II–IV), followed by lymph nodes on the contralateral side. Skip metastases, while unusual, can occur.

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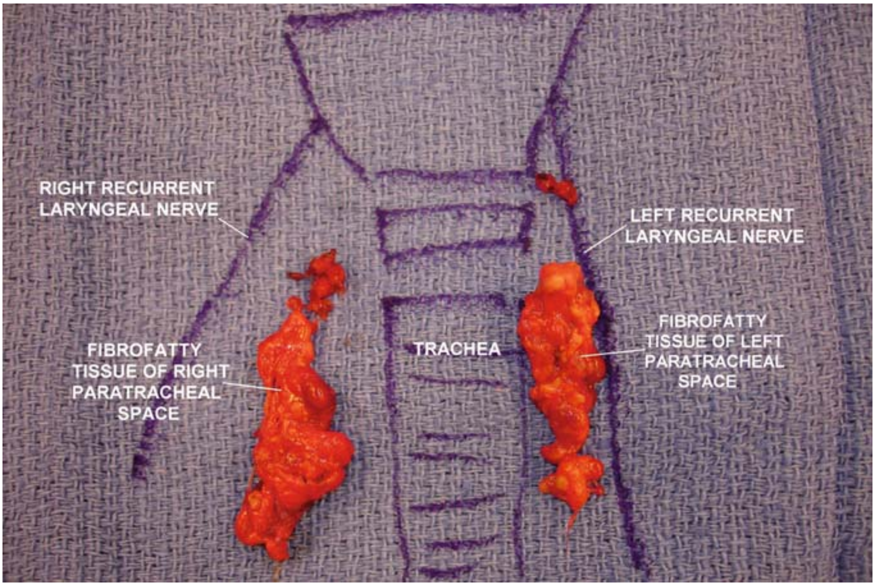

Fig. 2.1 Post-resection specimens from a patient who required bilateral central neck dissections

Central neck dissection for differentiated thyroid cancer is clearly indicated when central compartment lymph nodes are grossly involved with cancer. Central neck dissection is also indicated if an enlarged or suspicious lymph node in the central neck is found to contain metastatic thyroid cancer on frozen section analysis. The role of routine, prophylactic central neck dissection for papillary thyroid cancer is controversial. The American Thyroid Association (ATA) guidelines recommend considering routine central compartment neck dissection for patients with papillary thyroid cancer (recommendation category B) [5], while the current National Comprehensive Cancer Network guidelines do not advocate routine central neck dissection and only recommend it if lymph nodes are palpable or biopsy-proven positive for metastatic disease [6]. These guidelines are expected to change to parallel the ATA recommendations, however, when the newest version is released. In contrast to papillary thyroid cancer, routine, bilateral prophylactic central neck dissection is recommended in the treatment of medullary thyroid cancer [3, 6, 7] Fig. 2.1.

2.2 Preoperative Preparation

All patients with a diagnosis of thyroid cancer should have a preoperative ultrasound of the central and lateral compartments of the neck, with fine-needle aspiration biopsy of any suspicious lymph nodes [5]. If positive in the lateral neck, then

the patient will require a modified radical neck dissection in addition to total thyroidectomy and central neck dissection.

2.3 Position

The patient is positioned supine on the operating table with the neck extended and the arms tucked at the sides. A beanbag or shoulder role is used to help extend the neck. A foam ring is helpful to pad the head and hold it in place. All pressure points are padded. Semi-Fowler's or reverse Trendelenburg positioning is helpful to decompress the veins in the neck.

2.4 Description of Procedure

A curvilinear incision is made in a natural neck crease overlying the thyroid isthmus and carried through the subcutaneous tissue and platysma. Subplatysmal flaps are raised superiorly to the notch in the thyroid cartilage and inferiorly to the sternal notch. The strap muscles are opened vertically in the midline in an avascular plane. It is usually not necessary to divide the strap muscles for exposure. Total thyroidectomy is then performed in the standard fashion. Once the thyroid has been removed, the lymph nodes in the central compartment of the neck can then be addressed. The Delphian (precricoid) lymph node is located overlying the cricothyroid membrane and is often encountered and resected during the dissection of the thyroid isthmus and pyramidal lobe (if present).

Central compartment lymph node dissection involves resection of the fibrofatty lymph node-bearing tissue in the paratracheal and pretracheal spaces. The boundaries of this dissection are

1. Hyoid bone – superiorly
2. Carotid artery – laterally
3. Midportion of the anterior trachea – medially
4. Suprasternal notch – inferiorly
5. Prevertebral fascia – deep [1, 8]

Structures at risk during this dissection include the parathyroid glands (particularly the lower glands) and the recurrent laryngeal nerves.

The technique of central compartment lymph node dissection first starts by defining the medial and lateral boundaries of the dissection [8]. Medially, the fibrofatty tissue overlying the trachea is incised to the level of the suprasternal notch, exposing the anterior surface of the trachea. Laterally, the medial border of the carotid artery is dissected down to the prevertebral fascia. The thin fascial layer overlying the recurrent laryngeal nerve is then opened along its length and the nerve dissected away from the fibrofatty tissue of the central neck and gently retracted laterally. This dissection, which can usually be done sharply, extends from the

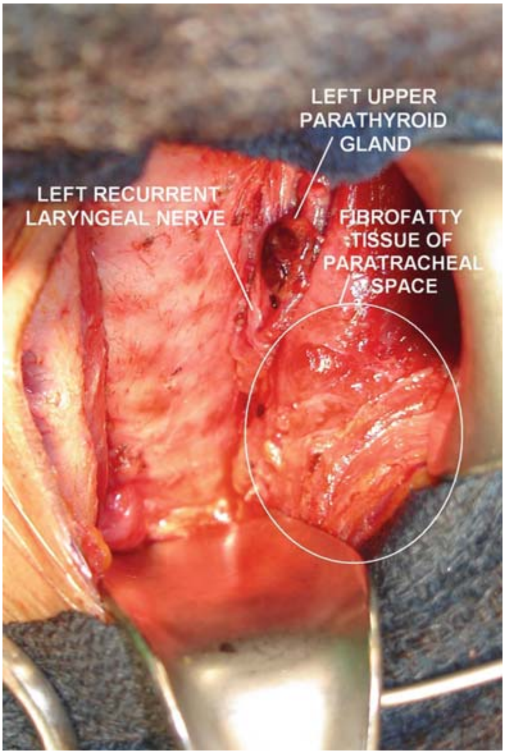

Fig. 2.2 Left central neck dissection. The left recurrent laryngeal nerve is partially dissected and the left upper parathyroid gland is visible in its normal position posterior to the nerve. The fibrofatty lymph node-bearing tissue of the paratracheal space is seen within the *ellipse*

point of the nerve's insertion into the cricothyroid muscle superiorly to the thoracic inlet inferiorly. Figure 2.2 illustrates the left recurrent laryngeal nerve partially dissected out at the beginning of the central neck dissection. The fibrofatty lymph node-bearing tissue of the paratracheal space is then taken off the prevertebral fascia in a cephalad-to-caudad and lateral-to-medial fashion, lastly freeing it from the trachea and esophagus. Figure 2.3 illustrates the appearance of the left central neck at the conclusion of the dissection. Care must be taken to preserve the upper parathyroid gland on its vascular pedicle. The lower parathyroid gland is frequently devascularized during a formal central compartment neck dissection and should be autotransplanted if its blood supply is threatened. Hemostasis is assured and closure is performed in the standard fashion. Drains are usually not necessary.

Bulky central compartment nodal metastases that invade the recurrent laryngeal nerve should be managed based on the histology of the primary tumor and preoperative vocal cord function. Papillary thyroid cancer should be "shaved off" a functioning recurrent laryngeal nerve in an attempt to preserve vocal cord function on that side, and these patients should receive postoperative adjuvant radioactive iodine. Because there are no good adjuvant treatment options for patients with medullary thyroid cancer, invasion of the recurrent laryngeal nerve may

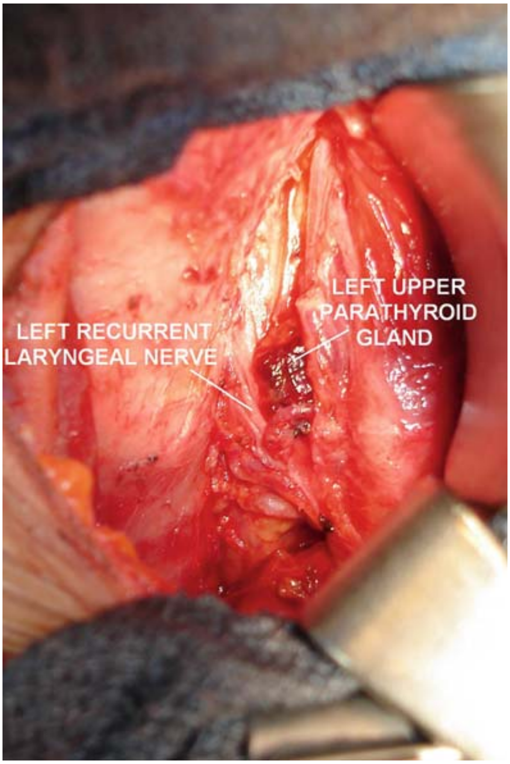

Fig. 2.3 Left central neck dissection. The left recurrent laryngeal nerve has been skeletonized and the fibrofatty lymph-node bearing tissue of the central neck has been removed

require en bloc resection of a segment of the nerve. Reanastomosis or nerve graft reconstruction can be performed to preserve muscle bulk on that side.

2.5 Postoperative Care

Patients are observed in the hospital overnight. The head of the bed is elevated to 30°. Clear liquids are given initially and the diet is advanced as tolerated. Recurrent laryngeal nerve function is assessed clinically by evaluating voice quality and aspiration of thin liquids. Serum calcium is checked on the morning after surgery, or sooner if there are symptoms of hypocalcemia. Oral calcium supplementation is given to patients at risk of perioperative hypocalcemia.

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Chapter 3
Modified Radical Neck Dissection

Cord Sturgeon and Dina M. Elaraj

3.1 Indications

The neck is divided into six lymph node-bearing compartments, which have been standardized by the American Head and Neck Society and the American Academy of Otolaryngology–Head and Neck Surgery [1, 2]:

I. Submental (IA) and submandibular (IB) triangle nodes.
II. Upper third jugular nodes located between the skull base and the hyoid bone. This compartment is subdivided into anterior (IIA) and posterior (IIB) to the spinal accessory nerve (CN XI).
III. Middle third jugular nodes located between the hyoid bone and the cricoid cartilage.
IV. Lower third jugular nodes located between the cricoid cartilage and the clavicle.
V. Posterior triangle nodes located between the anterior border of the trapezius muscle, the posterior border of the sternocleidomastoid muscle (SCM), and the clavicle. This group is subdivided into spinal accessory (VA) and supraclavicular (VB) nodes by a horizontal plane defined by the lower border of the cricoid cartilage.
VI. Central neck nodes located between the carotid sheaths extending from the hyoid bone to the suprasternal notch.

Although not technically in the neck, superior mediastinal nodes located between the suprasternal notch and brachiocephalic vessels are often included with the above lymph node groups and are designated as Level VII.

The classic radical neck dissection, which was developed primarily for the treatment of head and neck squamous cancers, involves removal of all the node-bearing tissue in Levels I–V along with the SCM, internal jugular vein, and CN XI.

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Numerous modifications of the original operation have been described. The term modified radical neck dissection (MRND) has been defined as an operation that involves preservation of one or more non-lymphatic structures routinely removed in the radical neck dissection, and the term selective neck dissection involves preservation of one or more lymph node groups/levels [1, 2]. Other authors have referred to similar operations as "functional" or "lateral" neck dissections, with the term "lateral neck" used to refer to Levels II–IV.

Papillary and medullary thyroid cancers frequently metastasize to the cervical lymph nodes. Thyroid cancer nodal metastases are best treated with formal compartmental clearance. There is no role for the selective removal of individual metastatic lymph nodes (berry picking) [3]. We typically perform formal nodal clearance of Levels IIA, III, IV, and VB, and in the text that follows we will refer to clearance of these node-bearing regions as MRND, even though technically the standardization of the definition of this operation also includes Level I [1]. The SCM, internal jugular vein, and CN XI are preserved, except in rare cases of invasive (usually poorly-differentiated) thyroid cancers.

Therapeutic MRND is indicated for biopsy-proven metastatic thyroid cancer [3, 4]. Prophylactic MRND is not indicated in the treatment of patients with papillary thyroid cancer. The role and extent of prophylactic MRND in the treatment of medullary thyroid cancer (MTC) is controversial, with some authors advocating routine prophylactic ipsilateral or even bilateral MRND based on patient's age, serum calcitonin, RET codon mutation, and presence of a palpable primary tumor [5, 6]. The National Comprehensive Cancer Network recommends considering prophylactic ipsilateral MRND in the treatment of MTC that is $\geq$1 cm (>0.5 cm if multiple endocrine neoplasia [MEN] 2B) or bilateral [4], while other consensus guidelines for the treatment of patients with MEN recommend MRND for patients with MEN 2 only if there is evidence of involved lymph nodes in the lateral neck [7].

3.2 Preoperative Preparation

All patients with a diagnosis of thyroid cancer should have a preoperative ultrasound of the central and lateral compartments of the neck, with fine-needle aspiration biopsy of any suspicious lymph nodes [3]. A thorough neurologic examination should be done to assess the baseline function of the nerves at risk during MRND. Preoperative laryngoscopy is recommended in cases of voice alteration or for revisional surgery, although many clinicians perform this routinely to evaluate baseline vocal cord function.

3.3 Description of Procedure

The neck is extended and the head turned to expose the lateral aspect of the neck. A beanbag or shoulder role is used to help extend the neck. A foam ring is helpful to pad the head and hold it in place. The patient is placed in semi-Fowler's position

to decompress the neck veins. The entire neck extending to the chin, corner of the mouth, and pinna of the ear, laterally to the shoulders, and down onto the upper chest is prepped and draped. The corner of the mouth should be visible through clear sterile draping.

Many skin incisions have been described for MRND [8]. An incision from the mastoid process carried inferiorly along the posterior border of the SCM, then curved medially in a Langer's line toward the midline yields excellent exposure with an acceptable cosmetic result. For simplicity, only the MRND through this hemi-apron or "hockey-stick" incision will be described herein.

The skin is marked in the proposed line of incision and infiltrated with 1% lidocaine with epinephrine to allow for sharp dissection in a relatively bloodless field. The skin, subcutaneous tissues, and platysma are incised sharply. Subplatysmal flaps are raised sharply toward the midline, taking care to preserve the greater auricular nerve and external jugular vein as the dissection proceeds over the surface of the SCM. The marginal mandibular nerve is preserved at the medial aspect of the subplatysmal flap.

3.3.1 Levels II and III

We recommend beginning the MRND in Level II. The fascia along the anterior aspect of the SCM is incised along its entire length and the internal jugular vein exposed and traced cephalad to the posterior belly of the digastric muscle. CN XI is usually identified as it crosses the internal jugular vein from medial to lateral or as it enters the posterior aspect of the SCM. The fibrofatty tissue found within the apex of the triangle bordered by the digastric muscle, internal jugular vein, and CN XI is swept inferiorly using sharp dissection (Fig. 3.1). Level IIA nodes are contained in this tissue. Level IIB nodes (found lateral to CN XI) are not usually included in the MRND unless there is clinical evidence of involvement. The dissection proceeds caudad and the fibrofatty tissue packet is sharply dissected from the posterior aspect of the SCM and the anterior surface of the scalene muscles. The lateral border of the dissection is the posterior border of the SCM. The dissection is continued caudad from the hyoid bone into Level III to the omohyoid muscle, which is an alternative surgical landmark for the inferior-most extent of Level III (Fig. 3.2). The sensory branches of the cervical plexus are preserved, if possible.

3.3.2 Levels IV and VB

The dissection is continued caudad along the posterior border of the SCM until the clavicle is reached. Many surgeons divide the omohyoid to maximize exposure. There may be additional node-bearing tissue inferior to the clavicle overlying the subclavian vein that should also be resected. Furthermore, the node-bearing supraclavicular (Level VB) tissue can be resected en bloc with Level IV by extending the dissection lateral to the posterior border of the SCM.

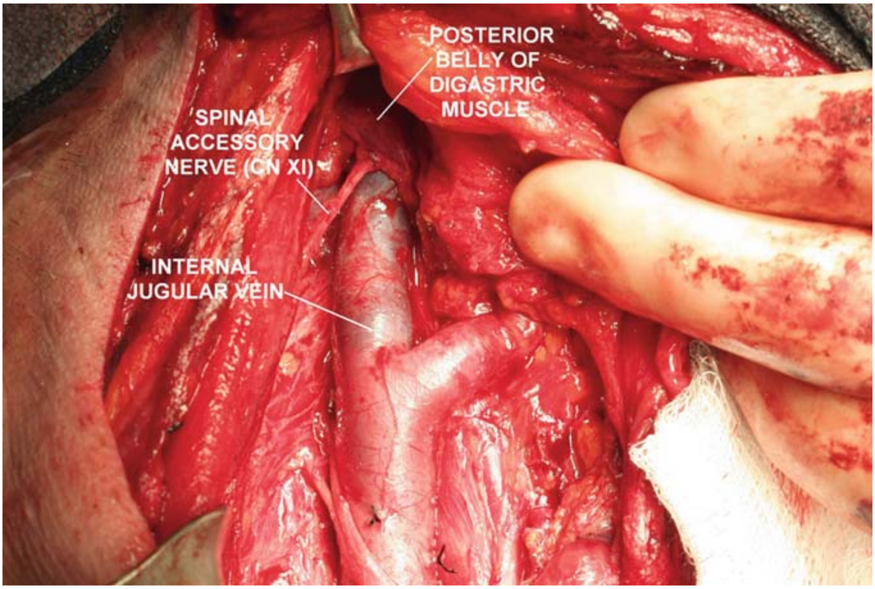
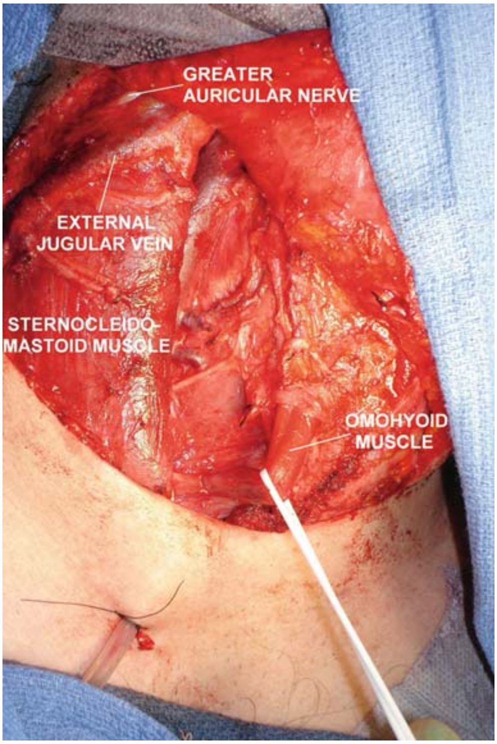


Fig. 3.1 Right modified radical neck dissection. The dissection is started in Level IIA at the triangle bounded by the posterior belly of the digastric muscle, the internal jugular vein, and the spinal accessory nerve (CN XI)

Fig. 3.2 Right modified radical neck dissection. The fibrofatty lymph node-bearing tissue of Levels IIA and III has been cleared. The omohyoid muscle is being retracted inferomedially. The external jugular vein and greater auricular nerve are visible on the anterior surface of the sternocleidomastoid muscle



3.3.3 Medial Dissection

The fibrofatty bundle is retracted medially and completely dissected off the deep cervical fascia overlying the scalene muscles. The medial border of the dissection is the carotid sheath. The phrenic nerve, vagus nerve (Fig. 3.3), transverse cervical artery, and brachial plexus are identified and preserved. Lymphatics joining the thoracic duct are individually ligated. The internal jugular vein is rolled medially to access the lymph nodes deep to the carotid sheath. The internal jugular vein can be sacrificed unilaterally for gross invasion. Dissection of the fibrofatty tissue packet is then completed sharply over the surface of the carotid sheath. Hemostasis is assured, the dissection bed drained, and closure performed in the standard fashion.

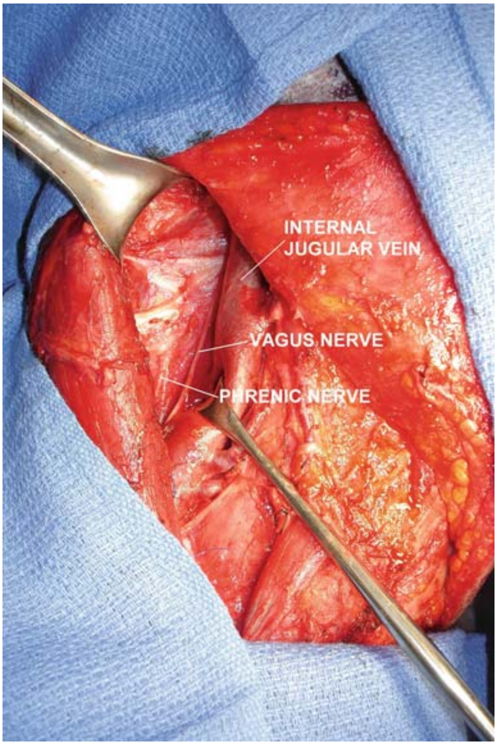


Fig. 3.3 Right modified radical neck dissection. The internal jugular vein is being retracted medially and the sternocleidomastoid muscle is being retracted laterally. The vagus nerve is visible posterior to the internal jugular vein and the phrenic vein is visible on the surface of the anterior scalene muscle

3.4 Postoperative Care

A chest radiograph is performed in the recovery room to rule out pneumothorax or elevated hemidiaphragm. The dissection bed is drained until output is less than 25–30 mL in 24 h and non-chylous. Laryngoscopy is performed for suspected vocal cord paresis when early diagnosis and intervention would improve outcome

(i.e., in cases of aspiration or potential airway compromise). Voice alterations are almost always temporary. Physical therapy is recommended for patients with CN XI paresis.

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Chapter 4
Parathyroidectomy

Lilah F. Morris and Michael W. Yeh

4.1 Indications

The diagnosis of primary hyperparathyroidism (pHPT) is established by demonstration of hypercalcemia in the presence of elevated or inappropriately normal parathyroid hormone (PTH) levels. Eighty-five percent of cases of sporadic pHPT are caused by a parathyroid adenoma – a single enlarged gland. Four-gland hyperplasia represents about 10% of cases, while double adenomas constitute 4% and parathyroid carcinoma <1%. While parathyroidectomy is the recommended treatment for patients with symptomatic pHPT, the need for surgical intervention in patients with asymptomatic disease is less clear. A National Institutes of Health (NIH) consensus statement, last updated in 2002, recommended surgical intervention for asymptomatic primary hyperparathyroidism in patients who meet a defined set of criteria (Table 4.1) [1].

Table 4.1 National Institutes of Health (NIH) updated 2002 consensus statement for recommending parathyroidectomy in patients with asymptomatic primary hyperparathyroidism

Age <50 years
Serum calcium >1.0 mg/dL above normal
24-h urine calcium >400 mg
>30% reduction in creatinine clearance
Reduction in bone density >2.5 standard deviations below peak bone mass
Medical surveillance not desired or possible

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4.2 Preoperative Preparation: Imaging Studies

Preoperative localizing studies may be performed after confirmation of the biochemical diagnosis. The most commonly used study is the ^{99m}Tc-sestamibi scan, which can correctly identify the site of abnormal parathyroid tissue in 75–90% of patients. Parathyroid ultrasound, an increasingly used method of preoperative localization, has an accuracy rate of 75–85% [2, 3].

4.3 Positioning and Anesthesia

The patient should be positioned supine on the operating table with the neck hyperextended and both arms tucked. For bilateral neck exploration, general anesthesia with endotracheal intubation is most commonly utilized. For minimally invasive parathyroidectomy (MIP), some centers use general anesthesia while others employ local/regional anesthesia with sedation (monitored anesthetic care or MAC). Regardless of the planned procedure, the surgical area should be prepped and draped to accommodate a bilateral neck exploration.

4.4 Description of the Procedure

4.4.1 Bilateral Neck Exploration

Bilateral neck exploration, with identification of all four parathyroid glands, has long been the standard approach to parathyroid surgery. A 3–4 cm central, transverse cervical (Kocher) incision is made along a skin crease 2 cm above the suprasternal notch. After the creation of subplatysmal flaps, the strap muscles are separated in the midline (Fig. 4.1). The plane between the sternothyroid muscles and the thyroid capsule is developed. The middle thyroid veins are divided to allow rotation of the thyroid gland anteromedially, as the majority of the parathyroid glands lie posterior to the thyroid. The elements of the carotid sheath are then retracted laterally away from the thyroid. A critical maneuver in parathyroid exploration is exposure and palpation of the prevertebral space that lies posterior to the esophagus. Indeed, failure to adequately interrogate the posterior (paraesophageal and retroesophageal) spaces of the neck is the most common cause of failed initial parathyroid exploration [4].

Normal parathyroid glands are yellow-tan in color. They are 5 mm in diameter, flattened or discoid in shape, and weigh between 30 and 50 mg. They are generally housed in a thin fatty envelope, giving them a classic “fried egg” appearance. Open exploration begins with interrogation of the superior parathyroid territory. Because of their shorter path of embryologic migration, the superior parathyroids are more consistent in their location than the inferior parathyroids, with the majority located within a 1.5 cm radius of the tubercle of Zuckerkandl, a posterolateral prominence of the thyroid gland. Other important nearby structures include the terminus of the

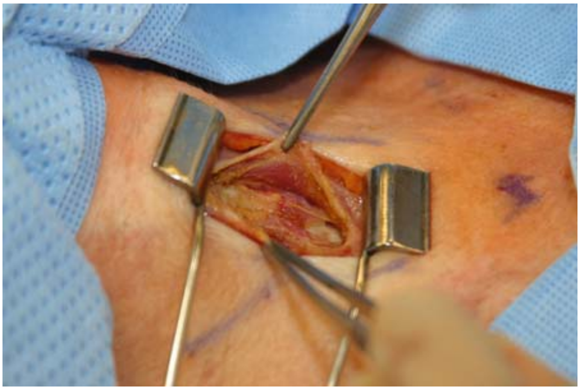

Fig. 4.1 Initial dissection for bilateral neck exploration. A central, transverse cervical incision lies 2 cm above the suprasternal notch (marked in *purple*, far right). Subplatysmal flaps are being retracted and forceps are elevating the divided strap muscles. The thyroid isthmus is visible

recurrent laryngeal nerve, arborization of the inferior thyroid artery, and the cricoid cartilage (Fig. 4.2). As superior parathyroid adenomas enlarge, they often slide inferiorly along the paraesophageal space. As a rule, the superior parathyroids are located posterolateral to the plane of the recurrent laryngeal nerve (Fig. 4.3) [5].

Though routine identification of the recurrent laryngeal nerve is not considered mandatory during parathyroid exploration, the surgeon must be extremely wary of avoiding nerve injury while operating near the superior parathyroids. A small fraction of parathyroid glands lie partially or completely embedded in the thyroid gland parenchyma; these may be either superior or inferior parathyroids.

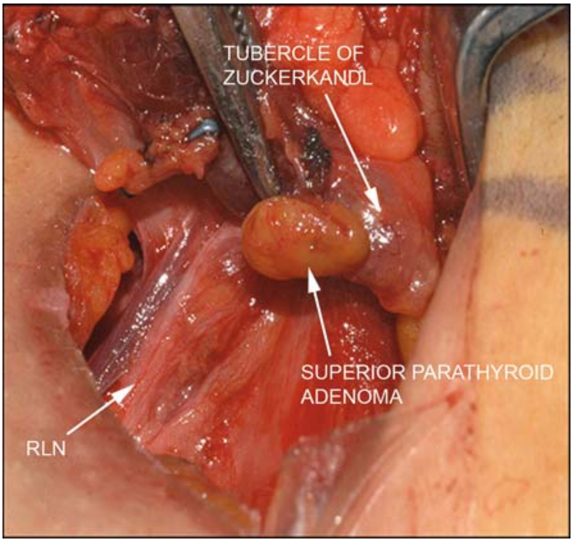

Fig. 4.2 Relationship of structures surrounding the superior parathyroid gland during a bilateral neck exploration. The superior parathyroid adenoma abuts the thyroid's tubercle of Zuckerkandl. The recurrent laryngeal nerve (RLN) can be seen traversing anteromedial to the gland (Photo courtesy of Dr. Leigh Delbridge)

The inferior parathyroid glands are located anteromedially to the plane of the recurrent laryngeal nerve (Fig. 4.3). The territory of the inferior parathyroid is relatively large, ranging from the superior pole of the thyroid to the anterior mediastinum. The majority of inferior parathyroid glands lie on the surface of the inferior pole of the thyroid, often near the inferior pole veins that demarcate the top of the thyrothymic tract. Inferior parathyroid adenomas can frequently be found by following the thyrothymic tract down into the chest. Ectopic inferior parathyroids are most commonly located in the thymus and can almost always be removed transcervically.

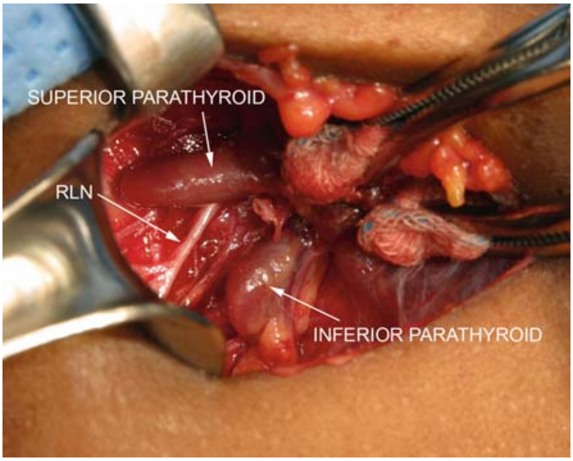

Fig. 4.3 Relationship of the recurrent laryngeal nerve (RLN) to the parathyroid glands during bilateral neck exploration for renal hyperparathyroidism. The thyroid gland has been retracted medially toward the patient's left

If three glands appear normal and one gland is enlarged, the diagnosis is a single parathyroid adenoma. The safest method of dissecting out a parathyroid adenoma is to start away from the vascular pedicle, mobilizing the lateral and inferior aspects while avoiding violation of the gland capsule. The vascular pedicle is isolated last and ligated with a hemoclip. Frozen section may be employed to confirm that resection of parathyroid tissue has been achieved.

After irrigation and hemostasis, the strap muscles and platysma are reapproximated. The skin is then closed in a subcuticular fashion.

If a four-gland exploration reveals hyperplasia (four enlarged glands), a subtotal parathyroidectomy is generally performed. This involves complete removal of the three most abnormal-appearing glands and partial resection of the fourth gland, leaving 40–50 mg of normal appearing tissue on an intact vascular pedicle. Should the remnant become devascularized, it can be excised, morcellated, and autotransplanted into either the sternocleidomastoid muscle or the brachioradialis muscle of the forearm.

4.4.2 Minimally Invasive Parathyroidectomy (MIP)

The strict definition of MIP is a limited (less than four-gland), image-guided parathyroidectomy involving an incision measuring $\leq$2.5 cm in length. Described techniques include (1) videoscopic, (2) video-assisted, (3) direct view central mini-incision, and (4) direct view lateral mini-incision [6]. We will describe the lateral mini-incision approach, which provides the most direct exposure of the parathyroid-bearing regions (Fig. 4.4). The incision site is placed directly over the parathyroid adenoma using ultrasound guidance. A 2 cm transverse incision is placed along a skin crease, centered over the anterior border of the sternocleidomastoid muscle. Small subplatysmal flaps are created. The sternocleidomastoid muscle is retracted laterally and the strap muscles are retracted medially. The thyroid is rotated antero-medially and the carotid sheath elements retracted laterally. After identification of the abnormal gland, dissection proceeds as in open exploration (Fig. 4.5). At the surgeon's preference, exploration of the territory of the non-excised ipsilateral gland can be undertaken at this point to evaluate for multiple gland disease.

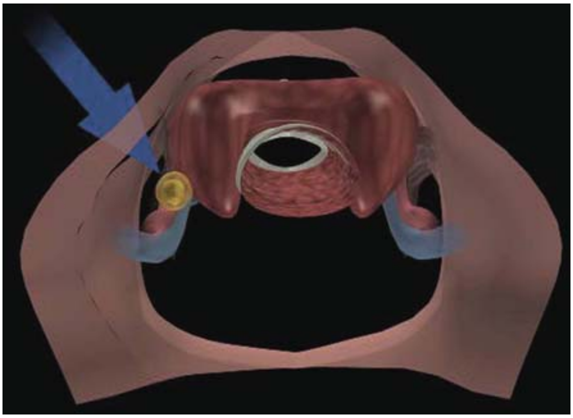

Fig. 4.4 An axial representation of the direct access to the parathyroid obtained using the lateral mini-incision technique

Fig. 4.5 Identification of an inferior parathyroid adenoma via lateral mini-incision technique. The adenoma was localized preoperatively with a functional ^{99m}Tc-sestamibi scan. Immediately prior to incision, the position of the gland was confirmed with surgeon-performed ultrasound and a 2 cm incision was made on overlying skin

Intraoperative PTH monitoring (IOPTH) is used by some centers to confirm complete removal of hyperfunctioning parathyroid tissue during MIP. Fall of the 10 min post-excision PTH value *to less than* 50% of the highest pre-excision value is highly predictive of long-term cure [7]. Failure to meet this criterion may prompt the surgeon to convert to bilateral neck exploration.

4.5 Postoperative Care

Parathyroid surgery has typically been followed by an overnight hospital stay, though a number of centers have moved to a same day discharge approach. Complications of parathyroidectomy are uncommon [8]. Hematoma occurs in approximately 0.3% of patients and requires emergent reexploration. Postoperative hypocalcemia may occur due to either iatrogenic hypoparathyroidism after four-gland manipulation or, more commonly, high-turnover bone disease and suppression of remaining parathyroid tissue in patients with biochemically severe disease. Symptoms should be assessed and treated with supplemental calcium as needed. The rate of permanent recurrent laryngeal nerve paresis is 1% or less in expert hands. The most common complication of parathyroid exploration is operative failure (persistent hyperparathyroidism), defined as hypercalcemia occurring within 6 months of operation. These patients require reoperation. The overall frequency of operative failure is not known, though at expert centers the rate is 2–5%.

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Chapter 5
Open Adrenalectomy

Raul Alvarado, Goswin Y. Meyer-Rochow and Stan B. Sidhu

5.1 Indications

Laparoscopic adrenalectomy has become the standard of care for the surgical management of functional and non-functional adrenal tumors [1, 2]; open adrenalectomy is utilized in the following situations:

1. Large adrenal tumors, usually over 10 cm in diameter [2].
2. Known adrenocortical carcinoma, preoperatively [3].
3. Conversion after laparoscopic inspection of an adrenal tumor and suspicion of malignancy intraoperatively. Such features include abnormally large tumor blood vessels, local invasion, and tumor thrombus inside the adrenal vein [4].

There are a number of approaches for open adrenalectomy including the retroperitoneal, thoracoabdominal, and the anterior or lateral transperitoneal approach. In our unit, we favor the lateral transperitoneal approach.

5.2 Preoperative Preparation

Preoperative workup is essential to diagnose a functional adrenal tumor. The common syndromes that require evaluation are Conn's syndrome, pheochromocytoma, Cushing's syndrome, and functional adrenocortical carcinoma, which usually has Cushing-virilizing features. Open adrenalectomy is usually reserved for large pheochromocytomas or functional and non-functional adrenocortical carcinomas [5, 6].

A full preoperative workup for hyperaldosteronism, Cushing's syndrome, and pheochromocytoma is reviewed in detail by Young [5] and Sidhu et al. [7].

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At induction, patients should have deep vein thrombosis (DVT) prophylaxis with subcutaneous fractioned heparin or equivalent, pneumatic calf compressors, as well as an indwelling catheter, and a nasogastric tube.

5.3 Positioning

The patient is placed in the lateral position with the operating table placed in maximal flexion to accentuate the space between the costal margin and the iliac crest. A beanbag is useful to secure the patient in position and appropriate strapping is provided (Fig. 5.1).

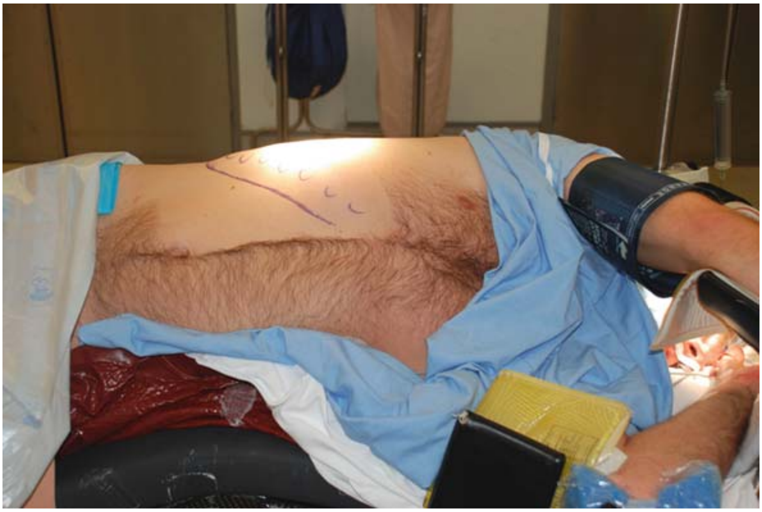

Fig. 5.1 The patient is placed in the lateral position. The operating table is then broken to maximize the space between the costal margin and the iliac crest. The beanbag is then aspirated to firmness to secure the patient in place

5.4 Description of the Procedure

5.4.1 Right-Sided Adrenalectomy

The costal margin is palpated and a subcostal incision two fingerbreadths below the costal margin is performed from the midclavicular line medially to the midaxillary line posteriorly. This incision can be extended down to the midline anteriorly, if required. The skin and underlying fat along this line are incised. The external oblique, internal oblique, and transverse abdominal muscles are divided using cautery. The peritoneum is then entered sharply, exposing the peritoneal cavity. At this point, full palpation of the peritoneal cavity is required to exclude metastatic disease.

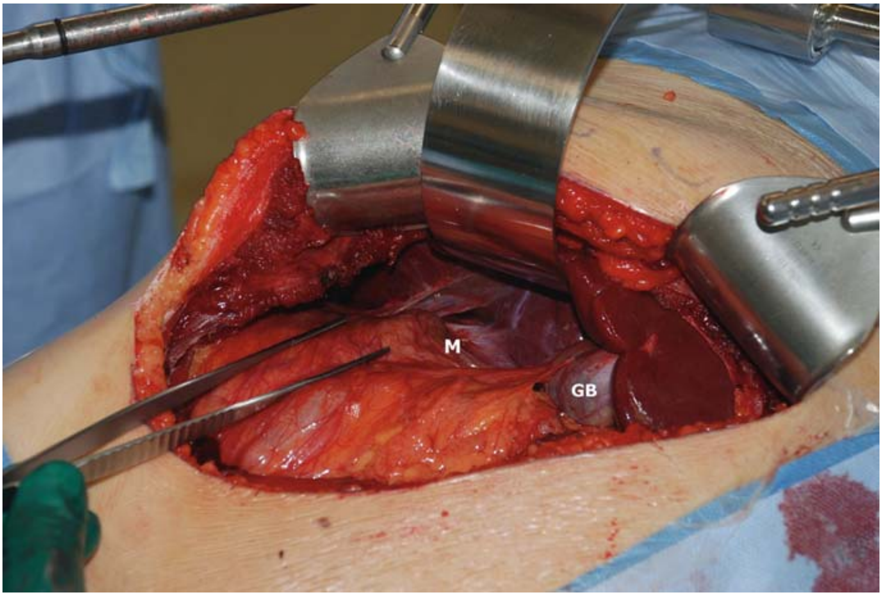

Fig. 5.2 A subcostal incision is made, the muscle layer is divided, and the peritoneal cavity entered. The triangular ligament is divided, the liver retracted superiorly, and the peritoneum of the hepatorenal pouch is divided to gain access to the upper border of the adrenal tumor (M). GB (gallbladder)

The hepatic flexure of the colon is mobilized and retracted inferiorly. The duodenum can then be kocherized to allow better access to the inferior vena cava (IVC). The liver is mobilized medially and superiorly by dividing the right triangular ligament (Fig. 5.2). Morrison'spouch is then entered by incising the peritoneum below the liver and overlying the adrenal gland. The superior margin of the adrenal tumor is identified. The lower margin of the tumor and the renal vein are identified inferiorly (Fig. 5.3). Medial to the tumor, the IVC can then be identified by a combination of sharp and blunt dissection after incising the overlying peritoneum. We aim to triangulate the dissection onto the adrenal vein from below and above (Fig. 5.4). With the patient in the lateral position, the adrenal vein is encountered as the IVC is passing under the liver. Once the adrenal vein is secured, the tumor is lifted off from the retroperitoneum and the feeding arteries, which arise from the inferior phrenic, the aorta, and the renal arteries are ligated and divided with a thermal sealing device.

5.4.2 Left-Sided Adrenalectomy

Open adrenalectomy on the left side is completely different to surgery of the right side. A subcostal incision is performed in a similar way with the patient in the left lateral position. The peritoneal cavity is entered and explored. Attention is directed

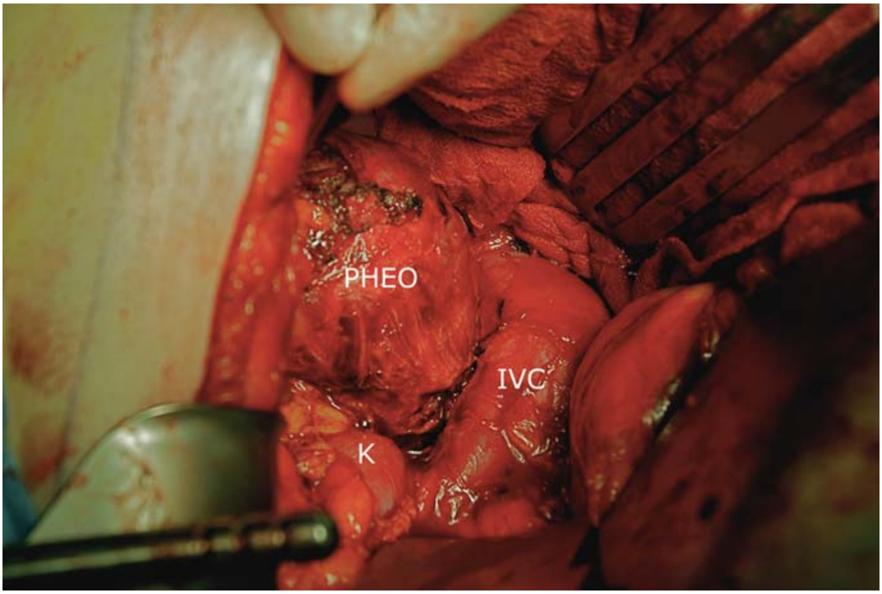

Fig. 5.3 Open adrenalectomy for a right-sided adrenal pheochromocytoma. Dissection is carried out along the lateral margin of the IVC, triangulating from above and from below to encounter the adrenal vein (not shown). Pheo (pheochromocytoma), K (kidney), IVC (inferior vena cava)

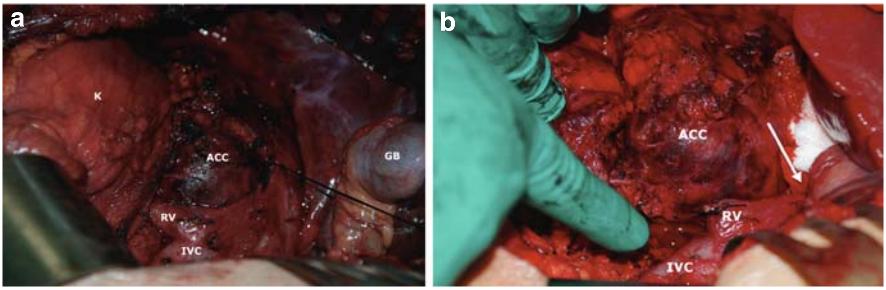

Fig. 5.4 Open adrenalectomy for a large ACC invading the right kidney. **a**. Right renal vein is identified below the inferior margin of the tumor. **b**. The renal vein has been divided. The *arrow* shows the putative position of the right adrenal vein. ACC (adrenocortical cancer), RV (renal vein), IVC (inferior vena cava), K (kidney), GB (gallbladder)

to the splenic flexure of the colon, which should be mobilized along the line of Toldt (Fig. 5.5). The lienorenal ligament is then divided and the spleen and tail of the pancreas are rotated medially (Fig. 5.6). The adrenal tumor can then be inspected and the renal vein is identified on its inferomedial aspect. The adrenal vein is then identified as it enters the left renal vein; it is often joined by the inferior phrenic vein prior to this point (Fig. 5.7). The adrenal vein is ligated and divided. The tumor

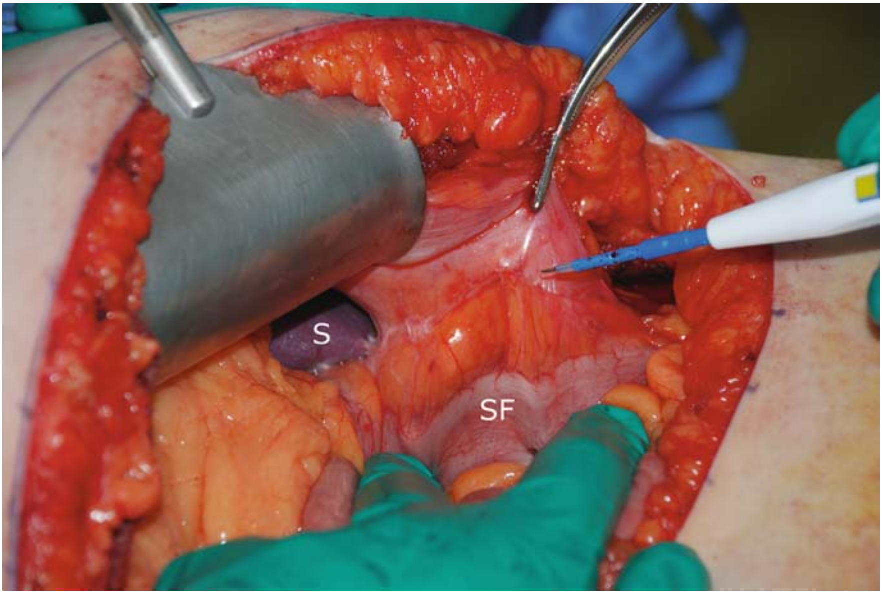

Fig. 5.5 Open adrenalectomy for a left 4 cm ACC. The splenic flexure of the colon is mobilized to expose the spleen, which is then medialized by dividing the lienorenal ligament. S (spleen), SF (splenic flexure)

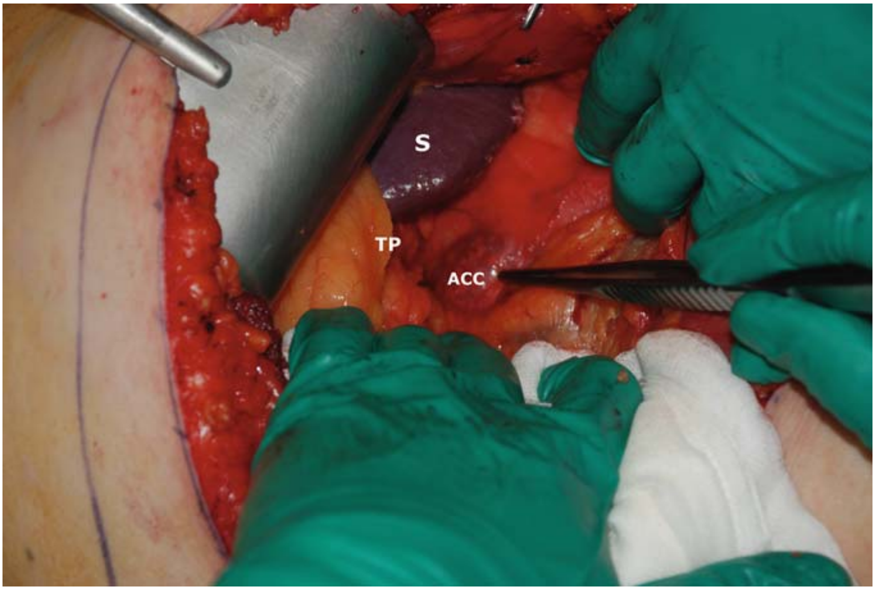

Fig. 5.6 The spleen and the tail of the pancreas have been medialized to expose the adrenal gland. S (spleen), ACC (adrenocortical cancer), TP (tail of pancreas)

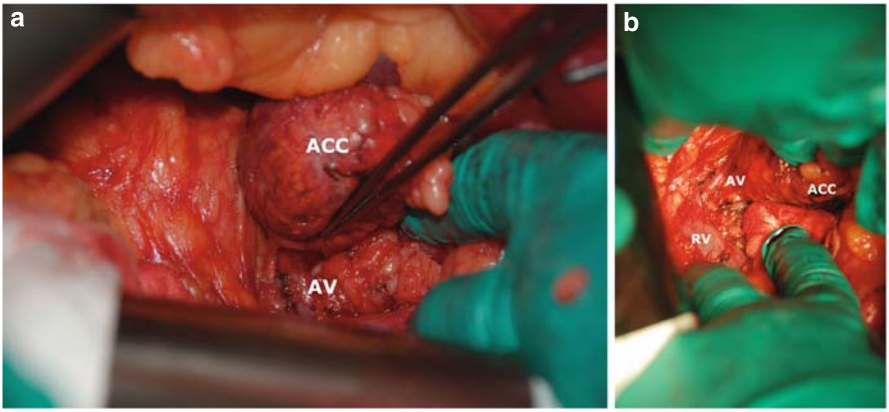

Fig. 5.7 **a**. The left adrenal vein is encountered on the inferomedial aspect of the gland. **b**. The left renal vein is identified; the adrenal vein is shown here draining into the left renal vein. AV (adrenal vein), ACC (adrenocortical cancer), RV (renal vein)

is then lifted off from the retroperitoneum and any feeding vessels are ligated and divided.

The use of drains is optional. The muscle layer is closed using a running non-absorbable suture. Skin is then sutured using an absorbable subcuticular stitch.

5.5 Postoperative Care

Patients should be observed closely for signs of bleeding and blood pressure should be monitored frequently. Signs of adrenal insufficiency should be addressed immediately, especially in patients with Cushing's syndrome. Electrolyte values are checked daily. Patients with Cushing's syndrome should be placed on IV steroids until able to take them orally. The urinary catheter can usually be removed on the first postoperative day as well as the nasogastric tube. Diet is recommenced once peristalsis is re-established. Patients are usually able to leave the hospital after the fifth postoperative day.

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Chapter 6
Laparoscopic Adrenalectomy

Shamly V. Dhiman and James A. Lee

6.1 Indications

In recent years, there has been a shift from open adrenalectomy toward laparoscopic adrenalectomy for the treatment of adrenal tumors due to such factors as decreased postoperative pain and faster recovery. Indeed, the majority of adrenalectomies in high-volume centers are performed laparoscopically. Indications for an adrenalectomy, whether open or laparoscopic, include a functional tumor, growth of an adrenal mass of 0.5 cm in 6 months based on imaging, adrenal tumor greater than 3–4 cm (since the risk of adrenal carcinoma increases with increasing tumor size), and isolated metastatic disease. The indications for laparoscopic adrenalectomy are essentially the same as those for open adrenalectomy with the notable exception of adrenocortical cancer, malignant pheochromocytoma, and large metastases. However, as skill and experience with laparoscopy increases, many authors have advocated laparoscopic adrenalectomy even for malignant disease. Contraindications for laparoscopic adrenalectomy also include general contraindications to laparoscopic procedures (such as severe cardiopulmonary risk and coagulopathy).

6.2 Preoperative Preparation

Upon discovery of an adrenal mass, the two main goals are to (1) determine if it is functional and (2) determine the risk of malignancy. History and physical exam may provide useful clues as to whether a tumor is functional, but biochemical interrogation is mandatory. If the tumor is non-functional the next task is to determine the risk for cancer. If a patient is found to have an adrenal mass and has a primary tumor elsewhere, he/she should be suspected of having metastatic disease. Patients with adrenal incidentalomas, however, should undergo age- and risk factor-appropriate

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screening. Aside from the presence of local invasion, the best indication of risk for adrenocortical carcinoma is tumor size. Based on size, the risk for adrenocortical cancer is < 4 cm $\sim 3\%$; 4–6 cm $\sim 7\%$; > 6 cm $\sim 25\%$ or greater. Below are the tests that should be performed as part of the workup for adrenal tumors.

1) *24-h urine metanephrines*: pheochromocytoma/paraganglioma
2) *24-h urine cortisol and low-dose dexamethasone suppression test*: Cushing's syndrome
3) *Plasma aldosterone and renin*: primary hyperaldosteronism
4) *Cross-sectional imaging (CT or MRI)*: localization and preop planning
5) *CXR, colonoscopy, mammogram, as appropriate*: metastatic disease workup
6) *Free testosterone, estradiol, dehydroepiandrosterone*: virilizing functional tumors
7) *Urinary 5-HIAA, octreotide scan*: carcinoid

Preoperative preparation for patients depends largely upon the pathology encountered. For most adrenal tumors, no special precautions are needed. However, with pheochromocytoma and Cushing's syndrome, specific measures are needed. For pheochromocytoma, preoperative alpha-blockade with repletion of intravascular volume is crucial to a safe and successful operation. Once the patient is adequately alpha-blocked and volume resuscitated, a beta-blocker may be started if the patient is tachycardic. Starting a beta-blocker prior to alpha-blockade may lead to unopposed alpha-mediated vasoconstriction that could precipitate a hypertensive crisis. In addition, it is essential that the anesthesiologist have short-acting drugs to combat hypertension and hypotension ready in the room prior to induction of anesthesia. For patients with Cushing's syndrome, it is important to give a stress dose of steroids prior to induction of anesthesia (typically, stress dose of steroids are not required for patients undergoing adrenalectomy for other reasons). In addition, patients with Cushing's syndrome should receive prophylactic antibiotics since they are more prone to infectious complications due to steroid excess.

6.3 Description of the Procedure

There are several approaches to laparoscopic adrenalectomy: transabdominal (lateral and anterior) and retroperitoneal (lateral and posterior). The duration of operating time is proportional to the experience of the operating surgeon, with both general laparoscopy and laparoscopic adrenalectomies. The laparoscopic lateral transabdominal approach is currently the technique of choice by most surgeons. However, some groups have found the laparoscopic retroperitoneal approach to have several advantages including shorter operative times, fewer complications (such as hernia), less postoperative pain, avoiding trauma to intraabdominal organs, and decreased physiologic impact on the cardiovascular and respiratory systems. Our discussion will focus on the laparoscopic lateral transabdominal approach.

6.3.1 Positioning

Patient positioning is often the hardest and most time-consuming part of the operation. Constant communication with the anesthesiologists and staff is critical to prevent mishaps. It is important to place the urinary catheter and to gather all the necessary positioning equipment prior to moving the patient. The patient is placed on a beanbag in the lateral decubitus position with the side of the adrenal tumor up. It is important to place the patient's costal margin 2–3 cm superior to the point where the bed flexes. Positioning here places the junction of the superior pole of the kidney and the adrenal gland at the break, allowing gravity to auto-retract the kidney inferiorly. The bed should be flexed maximally to increase the space between the costal margin and the hip to create more working space. In addition, a kidney rest should be elevated to further accentuate this space. The beanbag is inflated taking care not to push it into the abdomen, as this will decrease the intraabdominal working space. Rather the beanbag should be conformed to the patient's hip and chest to ensure secure positioning. The arms are placed in an ergonomically correct position, most often separated by pillows rather than with an arm sling. All pressure points are adequately padded and an axillary roll is placed. Pillows or blankets are placed between the legs in the usual decubitus position (Fig. 6.1).

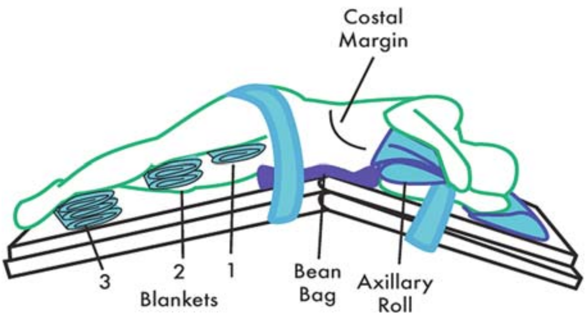

Fig. 6.1 This figure illustrates the proper decubitus positioning for a laparoscopic transabdominal adrenalectomy. It is very important to ensure that the inferior costal margin is positioned at the "break" in the bed

6.3.2 Port Placement

We typically enter the abdomen via a Veress needle technique at Palmer's point (2–3 cm inferior to the costal margin at the midclavicular line). On the left side, we place three ports subcostally about 5–10 cm apart, with the lateral-most port in the midaxillary line. On the right side, we typically place four ports in total (the additional port is for a liver retractor). When inserting the ports, it is important to "skive" the entry so that they are pointed toward the adrenal gland, otherwise you will have to work against the abdominal wall for the entire case. The camera is placed in the middle port and the surgeon works with a two-handed technique (Fig. 6.2a and b).

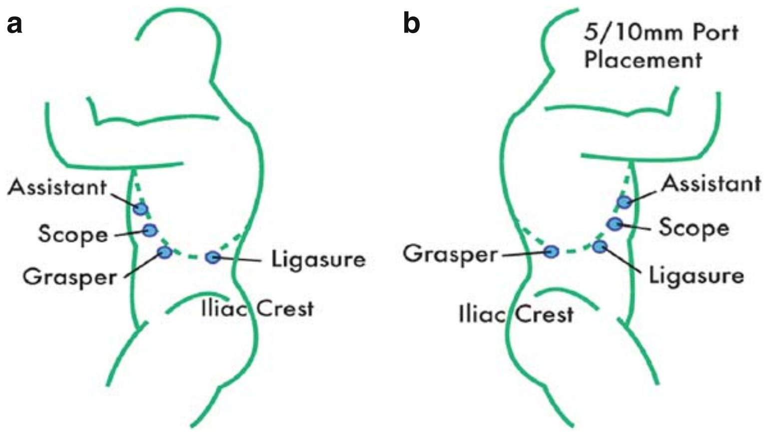

Fig. 6.2 **a:** Illustrates the placement of the ports for a laparoscopic transabdominal left adrenalectomy. Often, only three ports are used in a left adrenalectomy. **b:** Illustrates the placement of the ports for a laparoscopic transabdominal right adrenalectomy. In this case, the fourth port is used to place a liver retractor

6.3.3 Procedure

Although some authors advocate identifying and ligating the adrenal vein first, we do not adopt this strategy for the following reasons: (1) identifying the vein can sometimes be difficult early on, especially in obese patients, and (2) after ligating the vein, in cases of pheochromocytoma, the friable parasitic blood vessels characteristic of that disease dilate and lead to increased bleeding. The key to performing this operation successfully is respecting and exploiting the clear planes between structures. For this reason we use the hook cautery as a very precise means of following these planes. We use some form of vessel-sealing device to seal and divide vessels. The operation is divided into a series of steps popularized by Quan-Yang Duh at UCSF:

1. *Opening the book* – incising the peritoneum and Gerota's fascia to separate the adrenal gland and periadrenal fat from surrounding structures medially
2. *Reading from the top down* – opening the plane between the adrenal gland and periadrenal fat and the medial structures starting from the periadrenal fat tail superiorly and moving to the adrenal vein or renal hilum
3. Identifying and ligating the adrenal vein
4. Separating the adrenal gland from the superior pole of the kidney
5. Freeing the rest of the periadrenal attachments

6.3.4 Left Adrenalectomy

We first mobilize the splenic flexure by incising the lienorenal and lienophrenic ligaments to allow the spleen to fall medially with gravity. Using the hook cautery we stay 1 cm off the splenic capsule to prevent tearing the capsule. As we begin to incise the ligament at the superior pole of the spleen, it is important to identify and avoid the stomach, which lies just posteriorly. Once the spleen is medialized, the plane between Gerota's fascia and pancreas becomes readily identified. Retracting the spleen medially accentuates this plane. In obese patients, a fourth port for lateral retraction of the kidney and adrenal is sometimes helpful. The plane between Gerota's fascia and the pancreas is carried inferiorly (Fig. 6.3).

The splenic flexure often needs to be mobilized as you come to the superior pole of the kidney. Once the plane between spleen and Gerota's fascia is developed, we open Gerota's fascia superiorly and dissect through the periadrenal fat tail to identify the psoas muscle. We carry this dissection laterally 4–5 cm to allow for lateral and inferior retraction of the adrenal gland, as necessary. We then divide the periadrenal fat along the medial edge of the adrenal gland and carry this dissection toward the renal hilum. Multiple adrenal arteries will be identified and may be ligated with the electrocautery or vessel-sealing device as suitable. During this dissection the phrenic vein is often encountered and will lead to the adrenal vein (Fig. 6.4).

Another rule of thumb is that the splenic vessels "point" to the location of the adrenal vein. The adrenal and phrenic veins are dissected with careful blunt dissection and ligated either with clips or the vessel-sealing device. Once the vessels are divided, we identify the plane between the superior pole of the kidney and adrenal gland. When carrying out this dissection, it is important to watch out for a superior pole renal artery and avoid injuring it. The adrenal gland is then separated from the

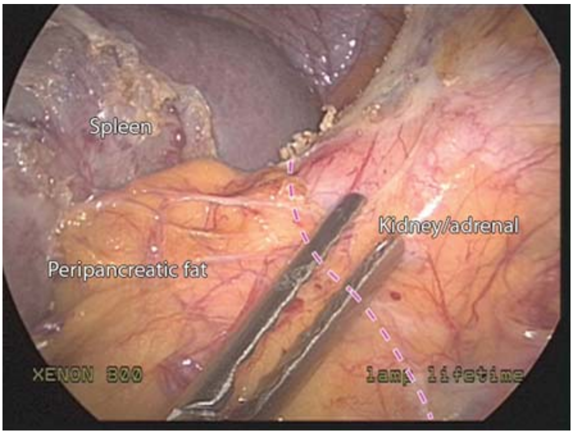

Fig. 6.3 This figure illustrates the line of dissection between the pancreas/spleen and the left adrenal gland

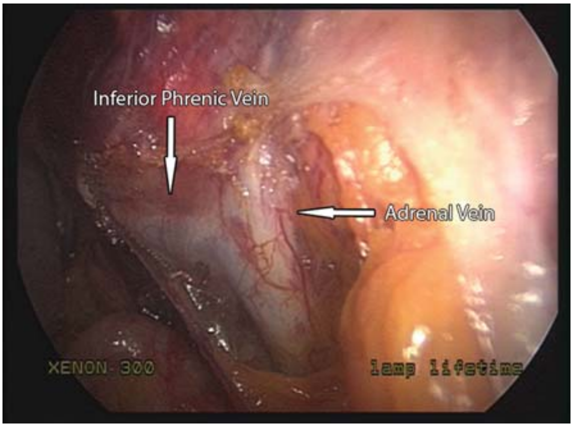

Fig. 6.4 This figure demonstrates the relative anatomy of the inferior phrenic vein joining the left adrenal vein. The common trunk then drains into the left renal vein

kidney. Then using a combination of blunt and sharp dissection the adrenal gland is liberated from the psoas muscle and lateral abdominal wall. Hemostasis is obtained with irrigation, aspiration, and electrocautery. The specimen is then removed in an impermeable specimen bag through the most anterior trocar. Enlarging the incision may occur for larger specimens. Fascial and skin incisions are closed.

6.3.5 Right Adrenalectomy

We first divide the triangular ligament and the filmy attachments in the bare area of the liver to fully mobilize the lateral portion of the liver medially. The inferior leaflet of the ligament will transition into the peritoneum and Gerota's fascia, which is divided carefully up to the lateral edge of the inferior vena cava. The dissection is then carefully carried along the lateral edge of the inferior vena cava. Once the Gerota's fascia, peritoneum, and triangular ligaments are widely incised, we

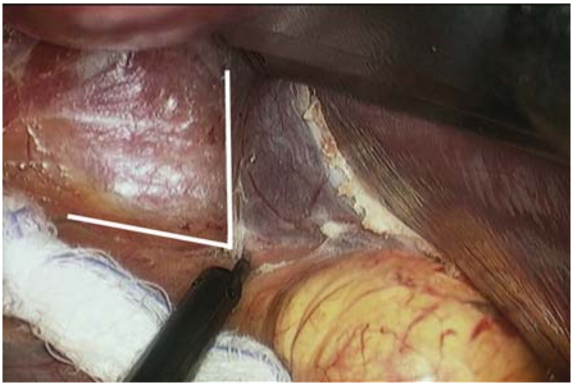

Fig. 6.5 The "V" illustrates the technique of creating a plane between the adrenal gland and liver, moving from superior to inferior. The liver is being retracted anteriorly and medially to expose the anterior surface of the adrenal gland

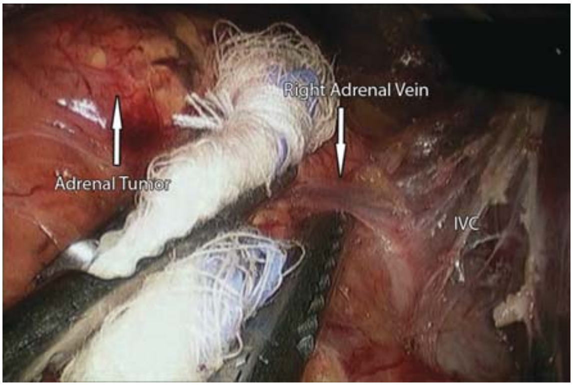

Fig. 6.6 This figure demonstrates the relative anatomy of the right adrenal vein, which enters the adrenal gland anteriorly. The right adrenal vein is relatively short and comes directly off the inferior vena cava (IVC) into the adrenal gland/tumor

mobilize the superior periadrenal fat pad as with the left side. Dissection is carried along the medial edge of the adrenal gland as described with the left adrenalectomy (Fig. 6.5).

The "V" illustrates the technique of creating a plane between the adrenal gland and liver, moving from superior to inferior. The liver is being retracted anteriorly and medially to expose the anterior surface of the adrenal gland.

Typically, a single adrenal vein enters the adrenal and inferior vena cava at the midpoint of the gland and is quite short (Fig. 6.6). The vein is dissected free and divided between clips or with the vessel-sealing device. The rest of the adrenalectomy proceeds as described for the left adrenalectomy.

6.4 Postoperative Care

A collaborative effort with the endocrinologists and general medical physicians is important to successful postoperative care. Postoperative follow-up is based on the particular pathology encountered and institutional requirements. The following are general guidelines for follow-up care, based on pathology:

1. *Aldosterone-producing adenoma*: Stop all aldosterone receptor antagonists and potassium supplementation immediately after the operation. Antihypertensive medications may be either stopped and added back as needed, or halved and adjusted as needed.
2. *Cushing's syndrome*: A rapid steroid taper to a low dose of oral steroids should be undertaken in conjunction with the endocrinologists. It is crucial to monitor these patients closely for signs and symptoms of adrenal insufficiency or frank Addisonian crisis.

3. *Pheochromocytoma*: Patients must be monitored for hemodynamic instability, especially hypotension. Postoperative hypotension should be treated with volume resuscitation. Repeat cross-sectional imaging and plasma metanephrines should be obtained in 6 months to rule out recurrent or metastatic disease.
4. *Adrenocortical cancer*: Patients should be enrolled in a clinical trial or placed on adjuvant chemotherapy such as mitotane. Repeat cross-sectional imaging should be obtained in 3 months to rule out recurrent or metastatic disease.

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Part II
Breast Surgery

Section Editor: Michael P. Sloan

Chapter 7
Breast Biopsy

Michael P. Sloan and Catherine Beckman

7.1 Introduction

Breast-related complaints remain one of the top reasons for consultation in general surgery. The most frequent reasons for evaluation include a palpable mass, radiographic abnormality, breast pain, nipple discharge, and infection. Mammography remains the imaging modality of choice, but is often supplemented with sonographic evaluation. Portable ultrasound has become an important adjunct to the physical exam in many breast surgery practices. The utility and application of MRI continues to be defined, as its expense, sensitivity, and specificity cause debate amongst surgeons and radiologists. The obvious concern in the mind of most patients is the possibility of malignancy. Adequate evaluation will typically involve a detailed history, examination, and imaging prior to any operative intervention.

7.2 Methods of Biopsy

The method by which a breast lesion is sampled is dependent on the indication for biopsy. The most common indication for biopsy is a radiographic abnormality on screening mammogram. Diagnostic mammography with compression/spot/magnification views should be performed in such cases. To assist in risk stratification, the American College of Radiology has developed a Breast Imaging Reporting and Data System (BIRADS) to standardize the criteria by which mammographic abnormalities are graded. The BIRADS score is provided to guide the surgeon toward the likelihood of malignancy. Scores of 4 or 5 warrant biopsy. Once a radiographic abnormality is identified, clinical exam should be performed to assess whether or not the lesion is palpable.

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The second most common indication for biopsy is a palpable mass. It is my opinion that all palpable masses should be imaged prior to biopsy. This limits the chance of distortion related to trauma from an attempted biopsy.

Imaging and clinical breast exam should be complete prior to an attempt at biopsy. In our institution, an ultrasound is often completed as part of the imaging sequence in both positive and negative mammograms. In part, this is driven by a preference to biopsy images under ultrasound guidance.

Non-palpable lesion

1. Stereotactic core biopsy
2. Ultrasound-guided core biopsy
3. Needle localized excisional biopsy

Palpable lesion

1. Ultrasound-guided core biopsy (if visible)
2. Core biopsy without image guidance
3. Excisional biopsy

7.2.1 Stereotactic Core Biopsy

This technique is based upon radiographic abnormalities that are typically non-palpable and often not identified on ultrasound. The most common indication stems from screening mammogram. Again the BIRADS score will typically guide intervention (See Figs. 7.1 and 7.2).

Although technique will vary slightly based upon equipment, some general principles apply. The surgeon must be aware of limitations to the technique that are patient-specific. Most stereotactic biopsy tables have a weight limit (often 300 pounds). The patient must be able to climb with assistance onto the table and tolerate being prone for at least 15 min. Depending on the size and travel of the biopsy device, the compressibility of the breast may negate the use of stereotactic biopsy. Likewise, lesions located immediately deep to the nipple/areola or near the chest wall may not be accessible by this technique.

7.2.2 Ultrasound-Guided Core Biopsy

Most palpable lesions and many mammographic abnormalities will have a correlate on ultrasound evaluation. When ultrasound shows a solid lesion, subsequent image-guided biopsy is often preferable to the patient. Ultrasound-guided biopsy is often more comfortable than stereotactic biopsy and remains less invasive than excisional biopsy techniques. Sonographic guidance confirms that the lesion in question was

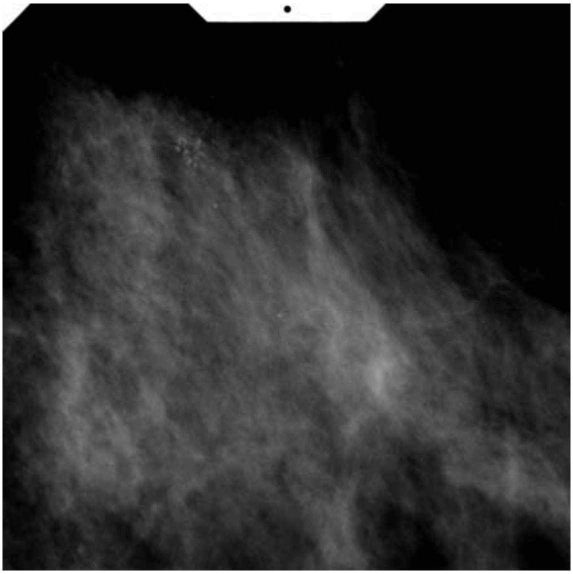

Fig. 7.1 Stereo 1

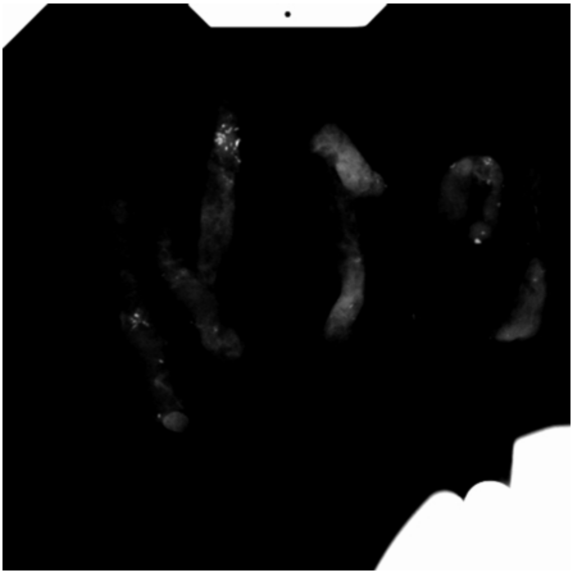

Fig. 7.2 Stereo 2

sampled, and also allows for placement of a radiographic marker for subsequent intervention or surveillance (see Fig. 7.3). Vacuum-assisted devices allow for multiple passes/samples through the lesion via a single access site (one small incision to insert the device).

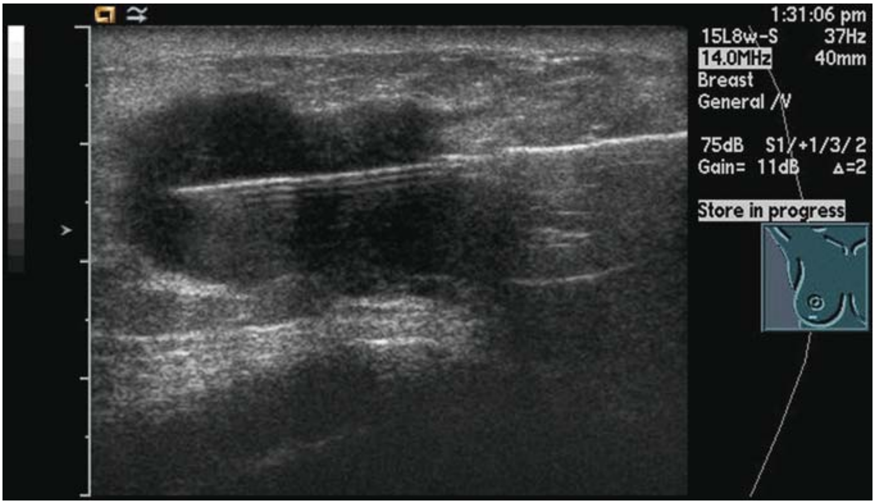

Fig. 7.3 US core biopsy

7.2.3 Core Biopsy

Palpable lesions can be sampled with a core biopsy needle in the office using local anesthesia. This often expedites the diagnosis in patients with large solid lesions and avoids multiple return visits.

7.2.4 Fine-Needle Aspiration

This technique has largely been replaced by core biopsy in all solid lesions. It does not provide histology and thus limits diagnosis. Cytology can be obtained to confirm carcinoma (more useful to confirm axillary nodal involvement). Its primary use at this point is for assessment of cystic lesions in the breast. Many simple cysts (based upon ultrasound) do not require aspiration unless symptomatic. Recurring cysts and complex cysts may be addressed with ultrasound guidance or by excision. The addition of a core biopsy is recommended if a solid component remains after aspiration.

7.2.5 Excisional Biopsy

For palpable breast abnormalities, this technique remains the most direct method by which a surgeon might obtain tissue and address the lesion. However, successful image guided biopsy often provides a diagnosis such that definitive operative care can be offered in one setting. Benign masses such as fibroadenomas are definitively

addressed by excision and pathologic conformation. Malignant lesions may require re-excision, based upon adequate pathologic margins.

Cosmesis is an important component to all operations and breast surgery is no exception. Almost all excisional biopsies should be placed along Langer's lines. This typically results in a curved circumareolar incision (think of a bull's eye pattern around the areola). Periareolar incisions work well and minimize scarring for more central lesions.

Excisional biopsy can be performed under local anesthesia alone or with sedation. Large lesions or patient preference may warrant general anesthesia, but this is less common. Local anesthetic with 1% lidocaine with epinephrine or 0.25% bupivacaine with epinephrine is preferred. I use a 50/50 mix of the two local anesthetics. The palpable lesion should be excised with a margin of normal tissue (a couple of millimeters is adequate if the lesion is known to be benign). When the lesion of interest is unknown, it should be treated as a malignancy (aim for 1 cm margin of healthy normal tissue). Cautery may obscure histologic assessment of the margins, but in cases of malignancy and close margins, re-excision is often warranted. I use cautery in a cutting mode in most cases, using a true coagulation mode where necessary for hemostasis. As an alternative a sharp scissors or scalpel can be employed. The use of a harmonic scalpel is becoming more common. Always confirm hemostasis, as breast hematomas can require a return visit to the OR. I prefer irrigation with plain water, although the oncologic significance of this is speculative at best.

Orientation of the lesion should conform to institutional standard if one exists. Otherwise, placement of a long stitch lateral and a short stitch superior should suffice. Closure should be completed only at the skin level. The deep dermis will be re-approximated with interrupted 3-0 Vicryl suture and the skin edge closed with a running 4-0 Vicryl or Monocryl subcuticular stitch. Closure of any tissue deep to the skin will result in deformity of the breast. Seroma formation is a normal part of healing and should be anticipated.

7.2.6 Needle-Localized Excisional Biopsy

Technically, this operation is the same as noted above. However, two distinctions should be noted. First, a better understanding of the true location of the lesion is necessary for successful excision as the lesion is likely nonpalpable. Second, confirmation of excision requires a specimen mammograph.

The entry site of the wire is often spatially separated from the lesion. Margins should remain at 1 cm. The size of the lesion is estimated by imaging. Communication between the radiologist and surgeon is necessary to relate the position of the lesion relative to the hook of the localizing wire (see Fig. 7.4). On occasion, more than one wire is used to localize a lesion. Multiple lesions can be excised relative to the position of a single wire or multiple wires.

From a technical standpoint, I find it easier to leave the needle in place as I begin the dissection. This allows for better palpation of the depth of the lesion,

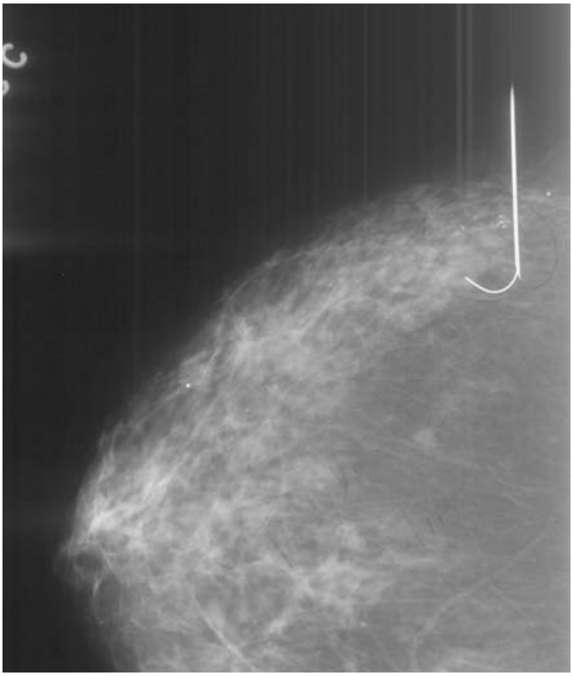

Fig. 7.4 Needle localization

which can be distorted on imaging. The needle is firm relative to the flimsy nature of the localizing wire. Most needles are marked externally to give the surgeon a sense of the distance to the needle tip. Once I have a three-dimensional sense of the location of the hook of the localizing wire, I remove the needle. If the entry site of the wire is not included in my incision, I firmly hold the wire in place relative to the lesion with a small clamp and relocate the external portion of the wire into the wound (remember the wire is flimsy and can be dislodged). Following radiographic confirmation of a successful excision, closure is completed in the same manner as noted above (see Fig. 7.5).

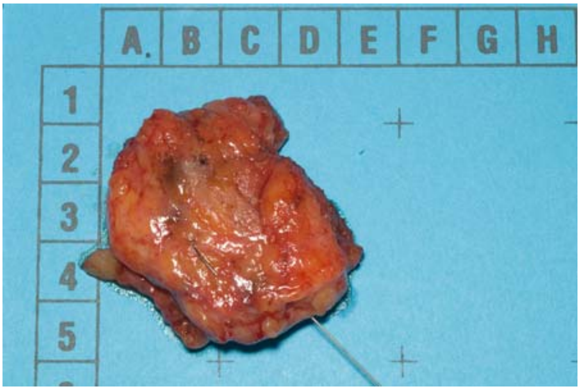

Fig. 7.5 Needle loc specimen

Chapter 8
Breast Procedures

Michael P. Sloan and Catherine Beckman

Prior to discussing partial mastectomy (lumpectomy), mastectomy (simple or total), modified radical mastectomy, and axillary operations, a brief review of the indications is necessary. Although no atlas can begin to cover the subtleties of breast cancer treatment, a few basic principles apply. Treatment of breast cancer should be viewed from a local (tumor), regional (axilla), and systemic approach. Thus a modified radical mastectomy is the summation of a total mastectomy with an axillary dissection (local + regional treatment). Simply put, each breast operation for invasive cancer will require a breast operation and an axillary operation. In situ cancer will require only a breast operation with one caveat (in the setting of extensive DCIS or suspicion for invasive cancer, if mastectomy is selected a sentinel lymph node biopsy should be considered). Up to 20% of high-grade DCIS lesions or large lesions (>4 cm) will harbor invasive carcinoma [1].

Indications for partial mastectomy include ductal carcinoma in situ and invasive ductal or lobular carcinoma. Lobular carcinoma in situ is not a standard indication for operative intervention, but signifies an increased risk of subsequent invasive breast cancer (either ductal or lobular). The operative goal of partial mastectomy is to remove all known carcinoma with negative margins. Historically, DCIS was often treated with mastectomy, but the acceptance of breast conserving therapy (BCT) in invasive cancer has changed our approach to DCIS. The role of adjuvant radiation therapy should be discussed with the patient prior to opting for BCT.

Contraindications to BCT include patients with prior radiation therapy to the chest, patients with contraindications to radiation therapy (early pregnancy), unacceptable cosmesis (large tumor/small breast), multicentric disease, and inability to obtain a negative margin.

Indications for mastectomy include all patients eligible for BCT as well as those with the contraindications noted above. Patients with inflammatory cancer or systemic disease are often treated with chemotherapy/radiation prior to any breast

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operation. Likewise, neoadjuvant treatment can be used in select cases to transition patients with large tumors from mastectomy to partial mastectomy if tumor response is appropriate.

8.1 Breast Anatomy

The extent of glandular tissue in the female breast varies significantly. The typical breast has tissue extending from the second to sixth rib vertically and from the sternum to the midaxillary line horizontally. The so-called Tail of Spence wraps laterally over the pectoralis minor and enters the axillary space.

The axilla is often described anatomically as a three- or four-sided pyramid. The base is formed by the axillary fascia (essentially the hair-bearing area of the axillary fossa). The anterior wall is formed primarily by the pectoralis major and minor. The posterior wall is composed of the latissimus and subscapularis muscles. The medial wall is essentially the chest wall covered by serratus anterior and the lateral wall (if you need a fourth wall) is the humerus.

Surgical anatomy within the axilla is often defined by nodal levels, based upon the relation to the pectoralis minor; level 1 nodes being lateral, level 2 deep to the pectoralis minor, and level 3 medial (the apex of the axilla).

8.2 Partial Mastectomy

The partial mastectomy (lumpectomy) is the cornerstone of breast conservation therapy. Technically, this procedure is almost identical to the excisional biopsy as described above. Although some authors suggest >1 cm margins, this is often excessive and results in poor cosmesis for larger tumors.

In the setting of non-palpable lesions, the surgeon must estimate the size of the tumor based upon imaging and keep this in mind relative to the location of the localizing wire. Again, 1 cm margins should be taken in hopes of achieving adequate pathologic margins. There is some debate as to the extent of pathologic margins necessary. This is true for both DCIS and invasive cancer. Recommendations range from 1 to 10 mm margins in DCIS and invasive carcinoma. No definitive study has been undertaken to determine an absolute guideline. What remains clear is that tumor cells at the margin subjects the patient to an unacceptable risk of recurrence and these cases mandate re-excision. In my practice, I recommend re-excision if pathologic margins are less than 2 mm [2].

The practice of additional margins at the time of partial mastectomy is not routine, but varies by institution and surgeon. A recent retrospective review of additional margins taken at the time of lumpectomy suggested that almost 50% of the patients that would require re-excision avoid re-operation when additional margins were obtained at the primary operation [3].

Following resection of the specimen, orientation is established with suture as noted in Chapter 7 (see previous section). Specimen radiograph is obtained for non-palpable lesions. Intraoperative gross assessment of margins can be performed with

pathology. My preference is to ink the true margin prior to any attempt at sectioning. This is done in cooperation with a pathologist. Additional directed margins can be obtained if they are not a matter of routine. Prior to closure, small clips are placed at all margins to assist in adjuvant radiation therapy. Most centers now use CT scanning to plan external beam radiation or catheter-based brachytherapy, but clips persist for subsequent breast imaging surveillance.

8.3 Simple/Total Mastectomy

Mastectomy can be performed with or without reconstruction. Skin-sparing mastectomy is often appropriate for cases where immediate reconstruction is desired, but demands careful attention to the thickness of skin flaps. At no point should the oncologic nature of this operation be jeopardized by cosmesis.

Choice of incision is dependent on plans for reconstruction and surgeon preference. In the setting of immediate reconstruction, I opt for a periareolar incision with a lateral extension if necessary. In the setting of prior excisional biopsy or attempted partial mastectomy, I prefer to re-excise the prior operative scar. Planning should be coordinated with your plastic surgery colleague. If the patient has opted against immediate reconstruction (or it is contraindicated), I employ an oblique elliptical incision from the inferomedial breast toward the axilla. Axillary dissection can be performed through this incision without difficulty. In the skin-sparing technique, the surgeon must decide whether lateral extension or a separate incision provides better exposure to the axilla.

The skin flaps of a mastectomy are determined by patient characteristics. Careful examination and adequate traction on the skin and breast tissue help define the breast capsule during dissection. Skin necrosis may result, but the primary goal remains excision of all breast tissue. My preference is to approach the dissection circumferentially rather than one quadrant at a time. I work my way to the clavicle, sternum, inframammary crease (fatty tissue overlying the rectus inferiorly), and laterally toward the anterior border of the latissimus. The exact lateral extent of the breast is quite variable, but excision should extend beyond all glandular tissue. In the setting of a modified radical mastectomy this fatty tissue at the base of the axillary pyramid is included as one specimen with the breast and axillary contents (see Chapter 9).

Once the anterior surface of the breast is free from the skin, I begin a medial-to-lateral dissection off the pectoralis fascia (see Fig. 8.1). I currently use electrocautery for this entire dissection. I begin at the inferomedial aspect of the breast and end with the axillary tail, which wraps around the pectoralis minor in most women. Care should be taken to avoid the medial pectoral nerve, which often wraps around or passes through the superolateral border of the pectoralis minor.

Once the specimen is free from the chest, I orient it with a long stitch lateral and a short stitch superior. The wound is irrigated with plain water and hemostasis verified. One closed system drain should be adequate for the mastectomy site. I prefer a 19 French Blake drain and suture this to the skin with 3-0 Nylon. The drain is placed to bulb suction after closure in layers (interrupted 3-0 Vicryl in the deep

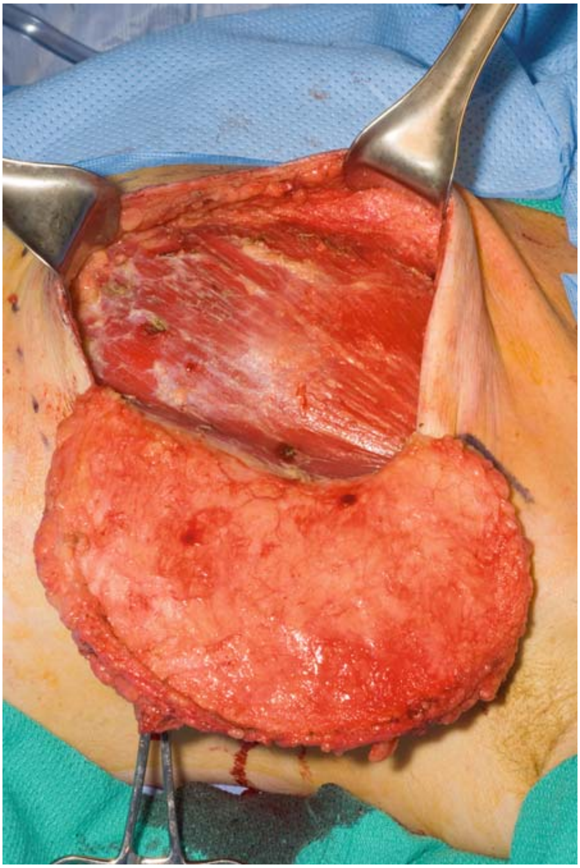

Fig. 8.1 Mastectomy

dermis and a running 4-0 Vicryl subcuticular stitch). A 6-inch ACE wrap around the chest works well as an immediate postoperative dressing, when reconstruction is not performed.

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Chapter 9
Axillary Procedures

Michael P. Sloan and Catherine Beckman

No discussion of breast surgery is complete without review of sentinel lymph node biopsy (SLNB). It has become routine for early breast cancer in most hospitals. Most surgeons consider SLNB the new standard of care, identifying equivalent false negative rates in axillary dissection. Indications for this technique of assessing the axilla continue to expand. The ability to identify a sentinel lymph node (SLN) varies from 94 to 100% in recent trials. The accuracy of this technique is estimated between 97 and 100%. False negative rates are reported between 0 and 15% [1].

The variability in these outcomes stems from the technique and experience of the surgeon. Current results tend toward 100% identification and accuracy. Many studies have now eliminated axillary lymph node dissection (ALND) in favor of SLNB.

The ability to offer this procedure is institution-dependent. All parties involved including radiology, surgery, and pathology should have experience. The techniques will vary by institution. My preference is to use both blue dye and a radiolabeled tracer. Both methylene blue and Lymphazurin (isosulfan blue) have been successfully used to stain the sentinel node. Methylene blue dye can cause skin necrosis and should not be injected intradermally. Lymphazurin has been reported to cause anaphylactoid reactions (0.7–1.9% in conjunction with radiolabeled sulfur colloid) [2]. For this reason I prefer all SLNBs are done under general anesthesia with a controlled endotracheal airway. I opt to inject the isosulfan blue in a periareolar intradermal location in the quadrant of the lesion to be resected. In other words, I inject 0.5–1 mL of dye on the face of the clock at the border of the areola where the breast lesion is located. Peritumoral injection is also adequate. The technetium-99m-labeled sulfur colloid is injected in radiology 1–4 h prior to the procedure in a peritumoral position. Lymphoscintigraphy is obtained to confirm localization (see Fig. 9.1)

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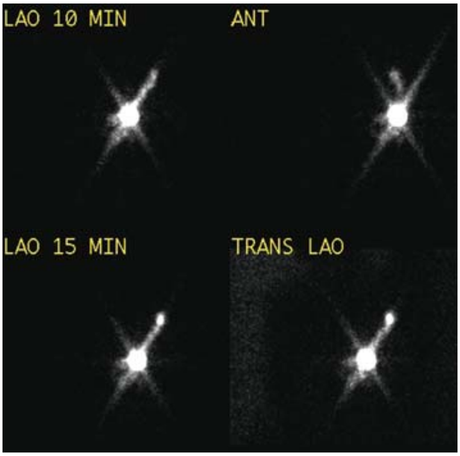

Fig. 9.1 Lymphoscintigraphy

For all axillary procedures, I position the patient with the involved arm on an armboard. Although some surgeons prep the arm within a stockinette for intraoperative repositioning, I have not found this to be necessary. The entire chest and axilla are prepared with chlorhexidine or DuraPrep after blue dye has been injected. A gamma probe is used to identify the general area of increased uptake within the axilla. I prefer a curvilinear incision at the base of the axillary hairline. This can be extended into an S-shaped incision for full axillary dissection. My dissection is guided by the gamma probe and any visible blue dye. I use cautery to dissect to the clavipectoral fascia and open this to expose the axillary fat and contents. From this point I use a dissecting instrument such as a tonsil clamp and cautery as necessary. Care should be taken to avoid injury to the thoracodorsal and long thoracic nerves at the depths of the axilla. Small clips are used on branching lymphatics. The first 2–5 blue nodes identified are considered the sentinel nodes. I observe for blue dye within the lymphatics to better guide my dissection (see Fig. 9.2). Infrequently will more than three nodes take up the dye, unless the dissection has been delayed.

The vast majority of cases will correlate with the Gamma probe. The highest in vivo counts guide you to the sentinel node. Ex vivo counts are recorded. All nodes within 10% of the value of the sentinel node (highest count) are removed, unless the number of nodes becomes excessive (more than 4 or 5). Again, this technique will typically identify 1–4 nodes and in most cases this correlates to those identified with blue dye. My preference is to always perform SLNB prior to the breast operation. This avoids the theoretical transfer of cancer cells to a clean operative site.

Closure is performed after irrigation and hemostasis. Plain water irrigation is used. No drains are necessary. I avoid closure of any deep layers in the axilla, unless the clavipectoral fascia is clearly identified. This layer may be reapproximated with interrupted 3-0 Vicryl suture. The deep dermis and subcuticular closure are completed, as mentioned above in the primary breast operations.

Fig. 9.2 Blue lymphatics

9.1 Axillary Lymph Node Dissection

The frequency of axillary dissection in our teaching institution has lessened dramatically over the past 5–10 years. Many chief residents perform this operation only once or twice in their training. However, the tenets of safe dissection and adequate axillary sampling have not changed. Two typical approaches are considered, medial-to-lateral and lateral-to-medial. I tend toward a hybrid approach, starting medial along the axillary vein, then returning from the lateral aspect once I have identified the thoracodorsal nerve and vessels. The most common indication for ALND is a prior finding of nodal involvement by SLNB.

In the setting of a modified radical mastectomy (MRM), I continue my medial-to-lateral dissection by entering the axilla via the clavipectoral fascia. I identify the axillary vein and typically find two small tributaries in the caudal direction, which I ligate with 3-0 Vicryl ties. As I proceed laterally along the vein, I typically encounter a vein in close approximation to an artery. Deep to these vessels lies the thoracodorsal nerve. These structures can be isolated in a vessel loop for future identification and preservation. I then begin a lateral-to-medial dissection from the latissimus muscle back toward the chest wall, preserving my thoracodorsal bundle. The long thoracic nerve lies below the fascia of the serratus anterior muscle and is often palpable from a medial or lateral position. It can be plucked like a bowstring. Remaining superficial to the investing fascia of the serratus will avoid injury, but the position of the nerve should be verified throughout the dissection (see Fig. 9.3).

I request that my anesthesia colleagues avoid paralytics in all breast cases. If necessary, I pinch the long thoracic or thoracodorsal nerve with a forceps to confirm their identity, although I try to avoid this if possible. Injury to the thoracodorsal nerve will result in weakness of adduction and internal rotation, but no obvious physical deformity is present. However, injury to the long thoracic nerve results in a winged scapula. This will become evident by the physical deformity in time. The subscapular nerve is at low risk for injury unless dissection is carried out to include level 3 axillary nodes. This should only be done when there is evidence of gross

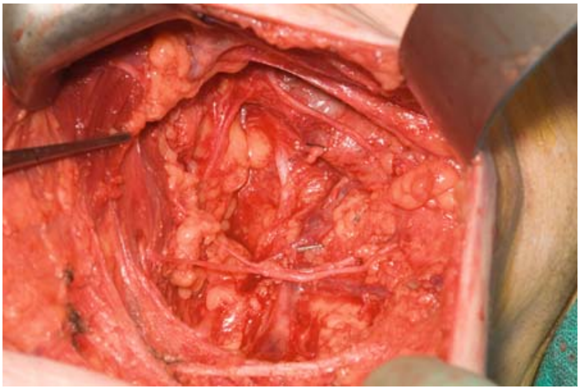

Fig. 9.3 Axillary dissection

involvement at level 2 or 3. The subscapular nerve lies against the subscapularis muscle near the apex of the axilla.

Drain placement has recently been debated in preference of an axillary bolster by some surgeons. However, I prefer to place a 19 French Blake drain from medial to lateral within the axilla. This is sutured to the skin with a 3-0 Nylon stitch and placed to bulb suction. Both breast and axillary drains can generally be removed after output falls below 30 mL over 24 h. Infrequently a seroma will occur after drain removal. I prefer to observe these unless symptomatic or if they delay adjuvant treatment.

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Part III
Esophageal and Gastric Surgery

Section Editor: Jon Gould

Chapter 10
Laparoscopic Nissen Fundoplication

Jon Gould

Gastroesophageal reflux disease is a common gastrointestinal condition. When medical therapy fails to adequately control symptoms, antireflux surgery is generally indicated. The most commonly performed antireflux operation is currently the laparoscopic Nissen fundoplication. During surgery, a consistent step-wise approach with attention to proper setup and common pitfalls can lead to good and durable clinical results with minimal long-term side effects.

10.1 Indications

Gastroesophageal reflux disease (GERD) symptoms are very common in the general population, affecting 40% of Americans once a month, 20% weekly, and about 7% daily [1]. Symptoms related to GERD can vary widely from patient to patient. The most common symptoms are 'typical' or esophageal symptoms such as heartburn and regurgitation. Other patients may suffer from extraesophageal GERD-related complaints such as cough, hoarseness, or severe asthma. Some patients experience a combination of esophageal and extraesophageal symptoms. Nissen fundoplication is indicated for cases of medically refractory GERD. Although several types of fundoplications can be performed (270-degree posterior Toupet, 180-degree anterior Dor), a full 360-degree Nissen fundoplication remains the most common antireflux operation. Most Nissen fundoplications are currently performed laparoscopically. As many symptoms related to GERD can also be caused by other conditions, it is important to confirm the diagnosis of GERD and the relationship of this condition to the symptom in question before proceeding with antireflux surgery.

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10.2 Preoperative Evaluation

All patients with suspected GERD under consideration for antireflux surgery should undergo flexible upper endoscopy. This is both to confirm the diagnosis and to rule out other pathology such as Barrett's esophagus. The identification of esophagitis at the time of endoscopy is highly specific (90–95%) but has a sensitivity of only about 50% for GERD [2]. In patients with esophageal symptoms and esophagitis, additional testing to confirm the diagnosis is usually not necessary. In patients with non-erosive reflux disease and in those with extraesophageal symptoms, which may be related to GERD, a 24-hour pH study or multichannel esophageal impedance testing is indicated to confirm the diagnosis. Additional tests that may prove helpful in some patients include Upper GI series, which can help to identify the anatomy. A nuclear medicine gastric emptying study is sometimes helpful in diagnosing gastroparesis in patients with GERD symptoms and significant bloating, nausea, or vomiting, especially in diabetic patients. Esophageal manometry is often performed prior to antireflux surgery to identify motility disorders that may affect surgical decision-making.

10.3 Positioning and Anesthesia

The patient should be positioned supine on a split leg table with arms out. Monitors are placed eye level at the head of the table. Steep reverse Trendelenburg position helps to expose the esophageal hiatus. Be certain that the patient is secured well to the table and that arms are padded and secured to the arm boards to avoid brachial plexus or other nerve injuries. The table height should be set such that the surgeon can operate with shoulders relaxed and forearms parallel to the floor. The surgeon stands between the patient's legs, and the first assistant typically stands to the patient's left side. An orogastric tube to decompress the stomach prior to placement of the esophageal bougie later in the case is a good idea before ports are placed.

10.4 Description of the Procedure

10.4.1 Port Placement

There are many acceptable methods of initial trocar placement and abdominal insufflation. We prefer to place a Veress needle at about the midclavicular line in the left subcostal position. Once pneumoperitoneum is established, we place a 5-mm optical trocar in this location. The abdominal pressure is set at 15 mmHg. This port site serves as the right hand operating port. Under direct visualization from within the abdominal cavity and using a 30-degree angled laparoscope, the camera port is placed next. This 5-mm port is placed superior to and slightly to the left of the

umbilicus. Care should be taken to avoid the epigastric artery on the left side with this port. Ideally, this port will be directly inline with the esophageal hiatus and approximately 10–15 cm below the base of the sternum. If the initial port has been placed correctly, it will lie to the patient's left of the camera port in order to avoid 'sword fighting' between the camera and right hand instrument. Another 5-mm port is placed about a hand's-breadth to the patient's right from the initial left subcostal site. This usually winds up being about two fingers right of the xiphoid. It is important to make sure that this port is at about the lower edge of the left lobe of the liver, especially for patients with very large livers. If optimally placed, these three ports will triangulate the esophageal hiatus with the optical axis of the laparoscope looking straight ahead at the hiatus. The assistant's 5-mm port is placed on the left side of the abdomen, in a subcostal location that will not interfere with the surgeon's right hand working port. A Nathanson liver retractor is placed through a 5-mm incision between the xiphoid and the left costal margin. The left lobe of the liver is retracted anteriorly and this retractor is connected to a robotic arm. With this setup, the assistant drives the camera with his/her left hand and helps the surgeon with exposure and retraction as necessary with the right hand. If a ski-shaped or other low profile needle is used in suturing, all ports can be 5 mm. If a larger needle is used, one of these ports (usually the left subcostal midclavicular port) needs to be at least 10 mm. The optimal location of these ports is illustrated in Fig. 10.1.

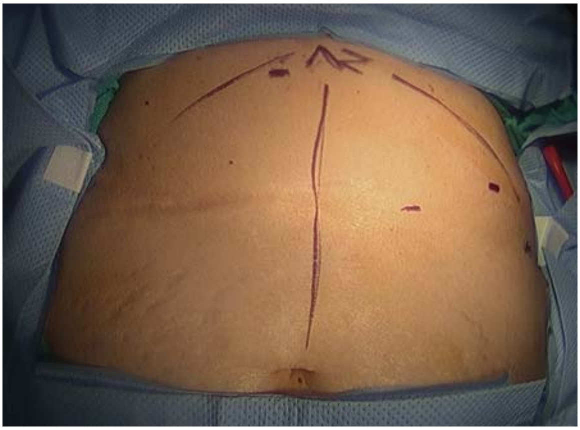

Fig. 10.1 Optimal port placement location for laparoscopic Nissen fundoplication

10.4.2 Hiatal Dissection and Esophageal Mobilization

Adequate elevation of the left lobe of the liver is essential for this procedure to go smoothly. The hiatal dissection typically begins at the gastrohepatic omentum. There is usually an area of this omentum that is transparent through which the caudate lobe of the liver can be seen. Approximately 20% of patients will have an aberrant left hepatic artery in this area. This should be identified and preserved if

possible. The dissection of the gastrohepatic omentum should be carried up to the right crus of the diaphragm. The assistant can grasp either the gastroesophageal fat pad, or some fat at the base of the right crus to facilitate this exposure. The phrenoesophageal membrane is then opened at the base of the right crus (Fig. 10.2). Care should be taken to avoid damaging the crural muscle during this step. The phrenoesophageal muscle can then be divided to its apex on the right using electrocautery, an ultrasonic dissector, or scissors. Once this membrane is divided, it is fairly easy to insert a blunt-tipped instrument medial to the right crus in the mediastinum. The surgeon's left hand instrument grasps or pushes the right crus to the patient's right while the surgeon's right hand instrument gradually and gently sweeps the esophagus and periesophageal tissue to the left to bluntly mobilize the esophagus. The posterior vagus nerve is usually clearly seen and should be swept along with the esophagus to the left. The right pleura and aorta are commonly encountered during this portion of the dissection as well. The left crural dissection is often best left until the fundus has been thoroughly mobilized and the medial border of the base of the left crus can be identified in the retroesophageal space from the anatomic left side.

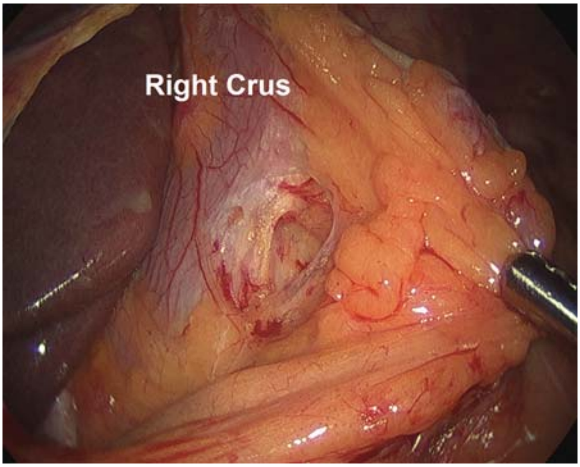

Fig. 10.2 Right crural dissection

10.4.3 Mobilize Fundus and Divide Short Gastric Arteries

Division of the short gastric vessels is begun at a point 10–15 cm inferior to the angle of His. This usually correlates with a point at about the lower pole of the spleen. The left lateral border of the fundus is grasped with the surgeon's left hand and retracted to the right. The gastrosplenic ligament is grasped, elevated, and retracted to the patient's left by the assistant. The surgeon's right hand is then used to create a window into the lesser sac between the short gastric arteries and the gastric wall. Once in the lesser sac, traction is maintained on the stomach and counter traction on

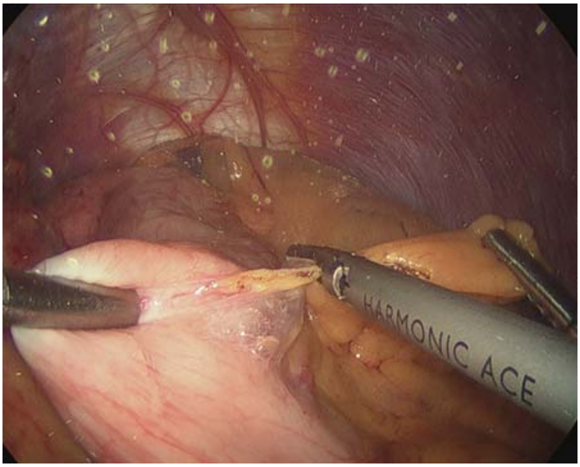

Fig. 10.3 Dividing the short gastric arteries

the gastrosplenic ligament to align the greater curve of the stomach with the visual axis of the laparoscope (Fig. 10.3). The short gastric arteries and all other posterior attachments of the stomach are then divided, usually with an ultrasonic dissector. It is important to avoid injuring the stomach by applying energy close to the gastric wall. It is also essential to avoid excessive traction, which may tear a short gastric artery or the splenic capsule. In some patients, the proximal fundus and upper pole of the spleen are seemingly fused, making this part of the dissection quite difficult. Once the fundus is fully mobilized, the base of the left crus can be visualized in the retroesophageal space from the left side (Fig. 10.4). The medial border of the left crus can then be dissected anteriorly back to the previously established plane

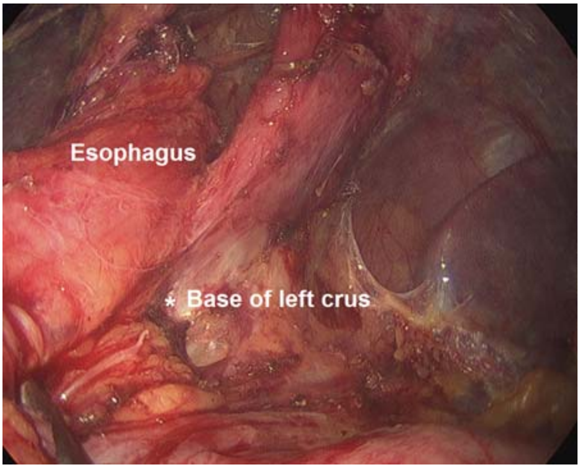

Fig. 10.4 Base of the left crus viewed from the anatomic left side behind proximal fundus and cardia

between the apex of the right crus and the mediastinum. A window posterior to the esophagus and proximal stomach can then be created from the anatomic left side.

10.4.4 Mobilize Esophagus

A Penrose drain can now be passed through this space and used to gently manipulate the esophagus (Fig. 10.5). Using the Penrose drain as a retractor, the distal esophagus can be circumferentially mobilized until at least 2–4 cm of distal esophagus lies comfortably on the abdominal side of the crura without tension. Take care not to injure the anterior or posterior vagus nerve, left or right pleura, or the aorta during this dissection. If either pleura is lacerated during this dissection, this must be communicated to the anesthesiologist. As long as the lung parenchyma itself is not injured, a small adjustment in airway pressure and intraabdominal pressure are usually all it takes to maintain normal ventilation.

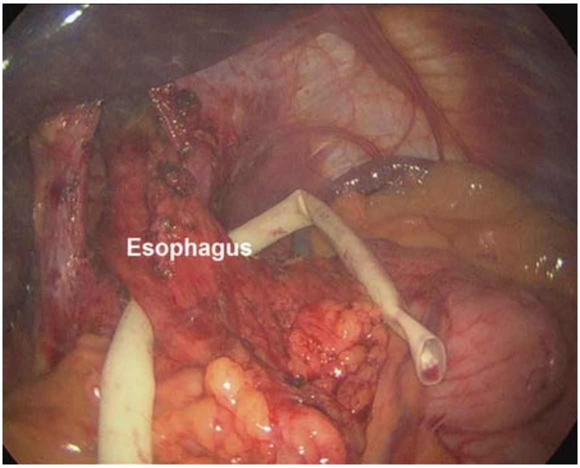

Fig. 10.5 Penrose drain around esophagus. The Penrose can be secure with an endoloop suture and used for atraumatic retraction of the esophagus

10.4.5 Crural Closure

Most surgeons perform Nissen fundoplication with the aid of an esophageal bougie. Passing the bougie can lead to an esophageal perforation and some experienced surgeons avoid this step [3]. We prefer to pass a bougie prior to approximating the crura. Most of the distal esophagus is visible at this stage of the operation. The keys to safe passage of the esophageal bougie are communication with the anesthesiologist, good visualization, and non-angulation of the gastroesophageal junction. We feel that a posterior crurопexy can angulate the esophagus anteriorly. Lifting the esophagus anteriorly for the cruropexy with a bougie within it can be difficult. The

use of a Penrose drain for retraction makes this easier. It is important to be sure that the bougie is not in so far that the tip is against the greater curve of the stomach, stretching the stomach along its longitudinal axis. This makes lifting the esophagus to expose the crura even more difficult. We use the bougie to calibrate our cruropexy. With a bougie in place, the crura should be approximated until there is just enough room to easily insert a blunt tipped 5-mm instrument into the mediastinum. The absolute size of the esophageal bougie is not terribly important. We generally use a 60 French bougie for men and a 56 French bougie for women and smaller men. If the bougie does not pass easily the first time, we select a bougie 2–4 French smaller and try again.

Most surgeons perform a posterior (as opposed to an anterior) cruropexy. We use 0-guage, non-absorbable, polyester suture (Fig. 10.6). The intraabdominal crural fascia is incorporated into the sutures rather than the muscle body alone. If the crural repair is under some tension, pledgets can be used. In cases where there is a large hiatal/paraesophageal hernia with attenuated crura and a large crural defect, it may be wise to consider using a biologic material or a product specifically designed to reinforce the crural closure. Crural/hiatal disruption is the most common mechanism of fundoplication failure [4]. There is evidence to suggest that reinforcement of the hiatal closure with a biologic material may decrease the incidence of hiatal disruption in paraesophageal hernial repair [5]. Mesh, especially polypropylene, should be used with great caution when it may come into contact with the esophagus as erosions can occur [6].

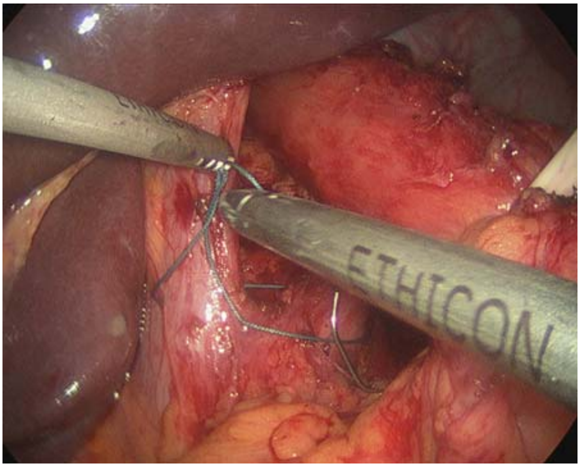

Fig. 10.6 Posterior cruropexy with bougie in place

10.4.6 Fundoplication

Creating a properly placed and 'geometrically correct' fundoplication is essential to achieve good GERD symptom control and to minimize dysphagia. The internal

diameter of the wrap should exceed external diameter of the esophagus. It is important to use the correct piece of both anterior and posterior fundus (well mobilized) to achieve this goal. In a correctly constructed fundoplication, the anterior and posterior wall of the fundus envelops the esophagus like a "hotdog in a bun." The anterior and posterior fundus should meet at the anterolateral portion of the esophagus, at about 10 o'clock. It is easy to twist the fundus as it is passed behind the esophagus and good visualization via a large retroesophageal window can help minimize the chance of this happening. Use the divided short gastric arteries for orientation and remember that when the fundus is passed from anatomic left to right, the posterior fundus actually is oriented towards the anterior abdominal wall [7]. If the body of the stomach on the greater curve (too low on the stomach and distal to fundus) is sutured to the posterior fundus, a "two-compartment stomach" is the result. These patients can suffer from persistent GERD symptoms, dysphagia, or both. Once the proper portion of the anterior and posterior fundus is identified to create a loose and floppy wrap, deep seromuscular stomach bites with a non-absorbable, braided polyester suture are used to create the wrap. The first bite is anterior to posterior fundus without incorporating any esophagus. The wrap is checked to ensure that the geometry is correct as described above before placing additional sutures. Ideally, the stumps of the divided short gastric arteries will lie on the anatomic left side of the wrap, directly opposite the suture line of the fundoplication. Additional fundoplication sutures (another 2–3 sutures) should include anterior esophageal muscle. Care should be taken to ensure that these are not full-thickness bites that might penetrate the esophageal mucosa. The proper wrap should be about 2–3 cm long and clearly located on the esophagus. Optimally, a small bit of distal esophagus will be visible distal to the wrap when complete. Identify and avoid the anterior vagus nerve. Once the fundoplication is completed, the esophageal bougie is removed. At this time, the fundoplication can be anchored to the intraabdominal diaphragm if desired. We

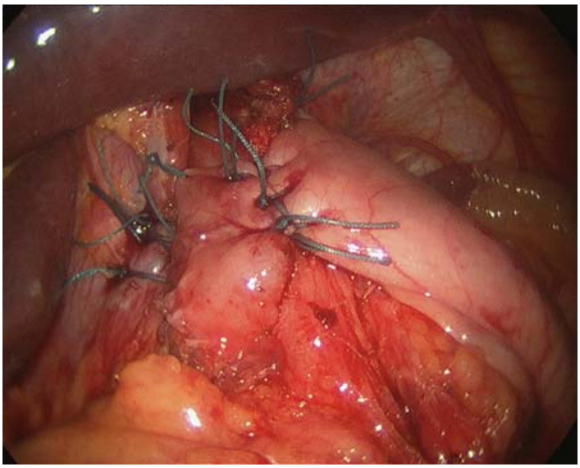

Fig. 10.7 Completed wrap anchored to the diaphragm

typically anchor the posterior wrap to the cruropexy. We also place sutures between the anterior crural pillar on both the left and the right and the anterior portion of the wrap on each side (Fig. 10.7). Each port site is infiltrated with bupivacaine for local anesthesia. The ports are removed under direct visualization from within the abdomen to ensure that there is no bleeding.

10.5 Postoperative Care

Pleural injury and pneumothorax are the result of inadvertent entry into the pleura during mediastinal dissection. This is rarely a clinically significant pneumothorax. For most cases transhiatal suction in the mediastinum with the ports open coupled with large vital capacity breaths administered by the anesthesiologist minimize the size of the pneumothorax. What little CO_2 remains in the pleural space is usually rapidly systemically absorbed. Chest radiographs are not necessary unless the patient experiences respiratory distress. We routinely administer ketorolac and ondansetron empirically to minimize the need for narcotics and to decrease the incidence of postoperative nausea and vomiting. Vomiting and retching in the immediate perioperative period has been shown to be associated with anatomic failure of the wrap or crural repair [8]. Because of post-fundoplication edema which can narrow the esophagus in the early postoperative period, we place patients on a pureed/soft diet for 2–8 weeks. It is important for patients to take small bites, chew thoroughly, and to eat slowly during these first few weeks. Strenuous physical activity that may require diaphragm straining (abdominal exercises, heavy lifting) should be avoided for about the first 4 weeks postoperatively

10.6 Complications

Dysphagia in the early postoperative period is common. Most patients will improve with time if this is related to wrap edema. Significant dysphagia that persists beyond 6 months occurs in about 3–4% of cases [9]. In these cases an improperly constructed wrap, excessively tight hiatal closure, or underlying motility disorder may exist. Endoscopy, upper GI series, and manometry can help to differentiate these causes of severe persistent dysphagia that lasts beyond 6–12 months. Occasionally, patients will require revisional surgery to take the wrap down, to revise it, or to convert a full to a partial wrap. Bloating symptoms and increased flatus following fundoplication are extremely common. As is the case with dysphagia, these "wind-related" symptoms do improve with time. Delayed gastric emptying can result, presumably from inadvertent vagus nerve injury during the esophageal dissection, although the incidence of this is poorly defined. Recurrent reflux can occur, usually related to anatomic fundoplication failure. The true incidence of recurrent GERD in long-term follow-up after fundoplication is probably in the range of 5–10% in the hands of experienced surgeons.

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Chapter 11
Laparoscopic Paraesophageal Hernia Repair

Jon Gould

11.1 Indications

Influential studies published by Belsey in 1967 and Hill in 1973 convinced surgeons for many years that all paraesophageal hernias should be repaired when identified, regardless of symptomatology [1, 2]. The rationale for this approach was prophylactic, based largely on a concern for life-threatening hernia-related complications such as strangulation and gastric ischemia. This notion has been challenged in recent years and now many asymptomatic hernias are managed expectantly [3]. When a hernia becomes more than mildly symptomatic, it should be repaired in most cases. Typical symptoms related to a paraesophageal hernia can include dysphagia, early satiety, epigastric pain, and even dyspnea. Some patients may suffer from significant medically refractory gastroesophageal reflux disease necessitating repair. Cameron's ulcers can develop from chronic mucosal ischemia and mechanical irritation from twisting of the stomach, typically at the hiatus. These ulcers may lead to chronic insidious blood loss with resultant anemia or less commonly frank hematemesis. Operative correction should be considered in these patients, as well.

The laparoscopic approach to paraesophageal hernia repair was described first in 1992 [4]. Since this time, it has been demonstrated that laparoscopic paraesophageal hernia repair is associated with many of the advantages observed for other laparoscopic procedures when compared to their open counterparts [5, 6]. Some authors have suggested that the recurrence rate following laparoscopic repair is too high [7]. Without prospective randomized trial comparing laparoscopic repair to other techniques and a clear consensus definition of what constitutes a meaningful recurrence, it is difficult to determine if these concerns are justified.

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11.2 Classification

Hiatus hernias can be classified into four types. In general, the indications for repair are the same in each. A type I hiatal hernia is often called a sliding hiatal hernia and is the most common of the four types. Patients with type I hiatal hernias are predisposed to reflux. Most patients with type I hiatal hernias undergoing surgical repair have met indications for antireflux surgery. In a type I hiatal hernia, the gastroesophageal (GE) junction migrates through the hiatus. A type II hiatal hernia is also called a "true paraesophageal hernia" or a rolling hiatal hernia. In these hernias, the GE junction maintains its normal intraabdominal position and the fundus herniates through the hiatus. Type II hernias are actually quite uncommon. Type III hiatal hernias occur when the GE junction and the gastric fundus herniate through the hiatus and represent a combination of type I and type II hernias. These hernias can become quite large (Fig. 11.1). Type IV hernias contain viscera other than the stomach such as spleen, colon, or small intestine.

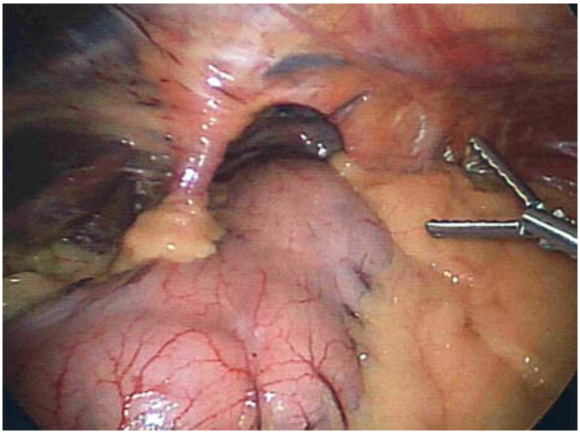

Fig. 11.1 Type III hiatus hernia. Gastroesophageal junction and fundus herniated through hiatus

11.3 Preoperative Evaluation

The preoperative evaluation can vary with the acuity, age, and medical condition of the patient. A sick patient with an incarcerated paraesophageal hernia and gastric ischemia may not require specific evaluation other than an exploratory laparotomy. Patients requiring paraesophageal hernia repair are often 70 years old and older, so proper medical and cardiac clearance can help to define or modify operative risk. An upper GI series helps to define the anatomy of the hernia and can identify patients at risk for having a "short esophagus." An upper endoscopy can identify Cameron's erosions or other intraluminal pathology. In cases where the primary indication

is gastroesophageal reflux disease, evaluation should proceed as described in Chapter 10.

11.4 Positioning and Anesthesia

The patient should be positioned supine on a split leg table with arms out as in the Nissen fundoplication procedure. The room setup is identical to that of the Nissen fundoplication, as well. Repair of very large hernias can take a significant amount of time (4 or more hours) and a bladder catheter as well as other invasive monitoring devices may be a good idea for an older patient or a patient with comorbid medical conditions.

11.5 Description of the Procedure

Port placement is identical to that described for the laparoscopic Nissen fundoplication. The basic principles of repair are (1) tension-free reduction of stomach and esophagus into the abdomen, (2) re-approximation of the hiatus, and (3) subdiaphragmatic anchoring of the stomach.

11.5.1 Hiatal Dissection and Esophageal Mobilization

Adequate elevation of the left lobe of the liver is important. The hiatal dissection typically begins at the base of either diaphragm crura. It is important not to grab the stomach and try to pull it into the abdomen forcefully. In some frail patients with large hernias, gastric injury can result from this maneuver. The stomach will gradually come down into the abdominal cavity as the hernial sac is dissected and mobilized. We prefer to divide the gastrohepatic omentum and to begin the hernia sac dissection at the base of the right crus. The hernial sac on the base of the right crus is grasped by the assistant and retracted to the patient's left. The white line of the phrenoesophageal membrane can often be visualized with this maneuver. We prefer the use of an ultrasonic dissector for the hiatal dissection. Hook electrocautery is another option employed by many surgeons. The phrenoesophageal membrane at the base of the right crus is opened and the posterior side of the hernia sac in the mediastinum is then visualized (Fig. 11.2). The dissection continues anteriorly on the front of the right crus to the apex. It is important not to damage the crural muscle fibers and to leave as much peritoneum on the crus as possible during this dissection. At the apex, the dissection of the hernial sac is carried down to the base of the left crus, eventually circumferentially dissecting the sac off the hiatal muscle. Excising the hernial sac from the base of the left crus can be difficult in some cases. Mobilizing the sac from its mediastinal attachments can be helpful. Dividing a few short gastric arteries on the greater curve and getting into the lesser sac on the

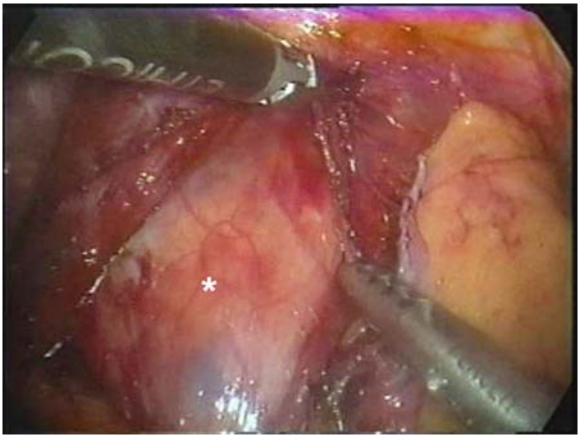

Fig. 11.2 The beginning of the sac dissection at the base of the right crus of the diaphragm. The mediastinal side of the hernial sac can be seen (*)

anatomic left side at the base of the left crus is a helpful maneuver, as well. Once the sac is freed from the diaphragm hiatus, the sac can be separated from its mediastinal attachments (Fig. 11.3). This process typically results in the complete reduction of any stomach still herniated at the beginning of this dissection. It is important to be careful to avoid injury to the esophagus as well as the vagus nerves and both pleural cavities. Aggressive, circumferential mobilization of the mediastinal esophagus typically results in adequate intraabdominal esophageal length. The hiatal defect is often quite generous in patients with large paraesophageal hernias, and with the use of an angled scope, esophageal mobilization well into the mediastinum is possible. With a transabdominal approach, at about the level of the inferior pulmonary vein continued cephalad dissection becomes increasingly difficult. Esophageal mobilization should be continued until at least 2–3 cm of intraabdominal esophagus

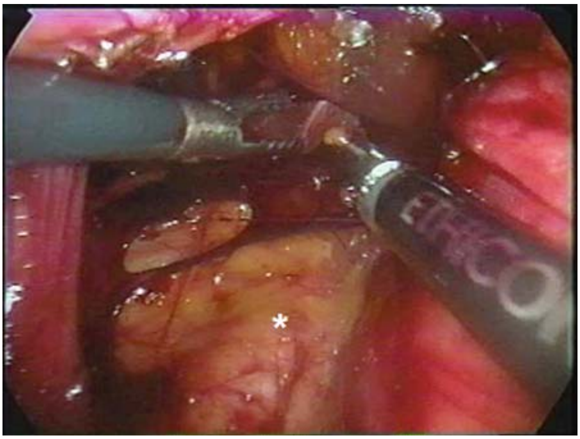

Fig. 11.3 Mediastinal mobilization of esophagus and attachments to hernial sac. The mediastinal aorta is encountered posterior to the esophagus (*)

is achieved without retraction or tension. In our experience and in the experience of others, this length of intraabdominal esophagus is nearly always attainable with a transabdominal laparoscopic approach [8]. Some authors advocate complete sac excision. In one study, complete sac resection significantly reduced recurrence rates from 20 to 0% [9]. We believe in removing or dividing as much sac as possible such that the anterior esophagus and GE junction can be clearly identified. It is easy to mistake posterior hernial sac for anterior esophageal muscle. Anchoring the fundoplication to the posterior sac rather than the esophageal muscle is an obvious setup for a slipped wrap or recurrence. It is also easy to mistake a tubularized stomach for the esophagus. In large hernias, the angle of His may no longer be an identifiable anatomic landmark. Visual identification of longitudinal muscle fibers of the esophagus, identification of the posterior vagus nerve, or even diagnostic endoscopy can be useful for localizing the true gastroesophageal junction in difficult cases.

11.5.2 Short Esophagus: Myth or Reality?

There is a lot of debate regarding the incidence, importance, and treatment of short esophagus in the literature. A recent review of 94 papers including more than 17,000 patients revealed an overall incidence of 1.5% [10]. In patients with a paraesophageal hernia, the reported incidence was about 11%. The pathophysiology thought to lead to the development of a short esophagus is chronic inflammation (due to esophagitis, scarring, or Barrett's) or anatomic changes associated with herniation. The diagnosis of a short esophagus is always made in the operating room after an earnest attempt at adequate esophageal mobilization. In patients in whom it is impossible to achieve 2 or more centimeters of intraabdominal esophagus, an esophageal lengthening procedure is an option. A Collis gastroplasty can be performed laparoscopically. A variety of techniques have been described. We prefer the proximal wedge gastrectomy technique as described by Hunter [11]. In addition to increased potential morbidity related to staple lines and a gastric resection, a Collis gastroplasty leaves acid-producing parietal cells in the neo-esophagus above the intact fundoplication. We believe that Collis gastroplasties should be used in paraesophageal hernia repair sparingly and only when absolutely necessary, for these reasons.

11.5.3 Re-approximation of the Hiatus

Adequate re-approximation of the hiatus will be facilitated by a meticulous and careful dissection of the left and right crural pillars during the initial phases of the procedure. Non-traumatized muscle covered with fascia will close primarily and hold a suture better than damaged and friable muscle fibers. The hiatus is closed posteriorly with 0-guage, non-absorbable, polyester suture (Fig. 11.4). Many surgeons routinely use pledgets. Erosion of pledgets into the esophageal lumen has

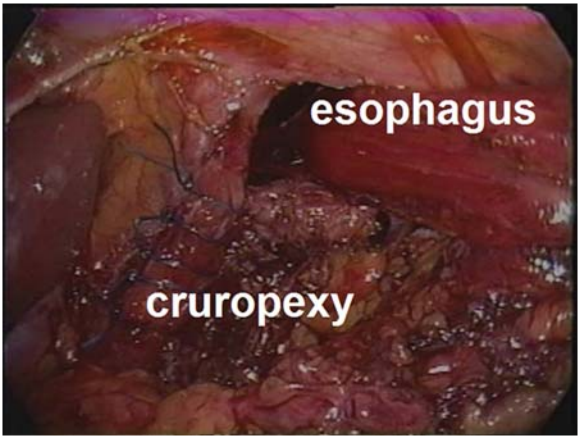

Fig. 11.4 Primary crural repair using interrupted sutures

been described; so, if pledgets are to be used it is a good idea to avoid using a pledget on the most anterior crural stitch that may come into contact with the esophagus. There is good data to support the routine use of a biologic material to reinforce the crural closure. In a prospective randomized study, porcine small intestine submucosa derived mesh resulted in a significant decrease in radiographic recurrences after 6 months when compared to non-reinforced hiatal closure in laparoscopic paraesophageal hernia repair [12]. In some cases, primary closure of the hiatus will not be possible and an interposition rather than an onlay technique must be used to achieve hiatal re-approximation. A "U-shaped" mesh configuration should be used (Fig. 11.5). Key -hole or other techniques of hiatus re-approximation with mesh, where the esophagus is encircled by mesh, are associated with a high rate of

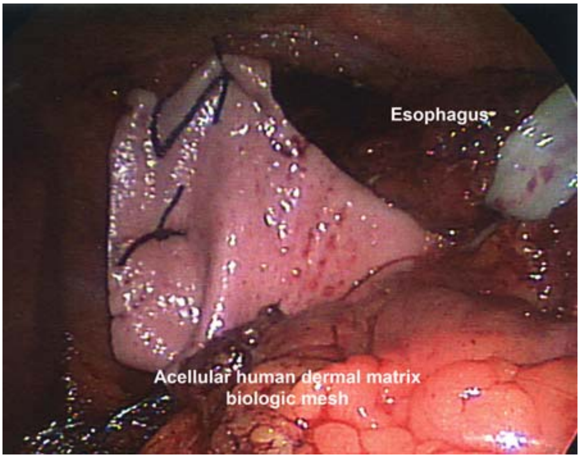

Fig. 11.5 Biologic mesh onlay re-approximation of the hiatus with the mesh in a "U-shape" configuration (* = esophagus)

esophageal and hiatal stenosis, in our opinion. Any permanent, non-biologic prosthetic mesh that comes into contact with the esophagus should be used with caution during hiatal repair as cases of erosion and significant resulting patient morbidity have been reported.

11.5.4 Subdiaphragmatic Anchoring of the Stomach

A number of techniques have been used to anchor the stomach to the abdominal side of the diaphragm. A sutured gastropexy, gastropexy via a gastrostomy tube, or a fundoplication can be employed to achieve this goal. For all but the most infirm and elderly patients, gastropexy without fundoplication is potentially associated with an unacceptably high recurrence rate [13]. The most commonly employed technique of subdiaphragmatic anchoring is with a fundoplication. This achieves the dual objective of anchoring the stomach to minimize the chances of recurrence and of correcting reflux in patients who also suffer from gastroesophageal reflux disease. When creating a fundoplication during paraesophageal hernia repair, division of the short gastric vessels may not be necessary in some patients with extremely mobile stomachs. Solid evidence to support one type of fundoplication over another (Nissen vs. Toupet vs. Dor) does not currently exist and all types of repairs have been described. At the University of Wisconsin, we typically construct a floppy 360-degree Nissen fundoplication. If an esophageal bougie is to be passed, this needs to be done very carefully. In patients with a large hiatal defect, the posterior crural repair can result in anterior angulation of the esophagus making esophageal perforation a concern during bougie passage. As described in Chapter 10, it is important to create a geometrically correct fundoplication. The anterior and posterior fundus should envelop the esophagus. A 2–3 cm long wrap should be constructed and anchored to the anterior esophageal muscle. We also suture the wrap to the cruropexy or the mesh posteriorly, as well as the anterior left and right crural pillars. Each port site is infiltrated with bupivacaine for local anesthesia. The ports are removed under direct visualization from within the abdomen to ensure that there is no bleeding.

11.6 Postoperative Care

Due to extensive mediastinal dissection, subcutaneous emphysema is commonly observed. This is rarely of clinical significance as long as the anesthesiologist has been attentive to the patient's PCO2 during the procedure. We do not routinely place nasogastric tubes. As long as patients are not suffering from nausea, we begin with a clear liquid meal within the first 24 h of the operation. Patients rapidly advance to a pureed or soft diet and remain on this diet for 2–8 weeks or until they can swallow without dysphagia. As is the case following Nissen fundoplication, we routinely administer ketorolac (as long as age or renal function does not present

a contraindication) and ondansetron empirically to minimize the need for narcotics and to decrease the incidence of postoperative nausea and vomiting.

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Chapter 12
Minimally Invasive Surgical Treatment of Achalasia

Sandeepa Musunuru and Jon Gould

12.1 Indications

Achalasia is a rare primary motility disorder of the esophagus with an incidence between 0.3 and 1/100,000 per year [1]. Failure of the lower esophageal sphincter (LES) to relax results in a functional obstruction that progresses to hypomotility and aperistalsis of the esophagus. Although the etiology is unclear, the pathophysiologic mechanism involves the destruction of myenteric plexi. Presenting symptoms usually involve dysphagia of liquids and solids, chest pain, and regurgitation of undigested meals [1, 2]. Pharmacologic agents such as calcium channel blockers and nitrates, pneumatic esophageal dilation, and botulinum toxin A (Botox) injection are temporary solutions that provide no sustained therapeutic benefit in many cases [1]. Laparoscopic Heller myotomy has been found to be an effective, safe, and long-term solution to relief of dysphagia in patients with achalasia.

12.2 Preoperative Evaluation

Initial evaluation of patients with suspected esophageal dysmotility may involve a barium esophagram, which classically demonstrates a smooth tapering of the distal esophagus, resulting in a "bird's beak" deformity. A swallow study can also identify patients with megaesophagus or a sigmoid esophagus, who may benefit from immediate treatment [2]. Upper endoscopy provides examination of the esophageal mucosa as well as examination of the gastroesophageal (GE) junction for strictures or distal esophageal tumors that can mimic achalasia (pseudoachalasia) [3]. Esophageal manometry, considered the gold standard for the diagnosis of achalasia, will demonstrate a poorly or non-relaxing LES in patients determined to have achalasia. Absent peristalsis of the esophageal body is also commonly observed

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on manometry [3, 4]. Other factors that should be taken into consideration when determining the appropriate therapy include the patient's age, overall medical condition, and prior nonsurgical treatments for achalasia. Multiple sessions of pneumatic dilation or Botox injection can result in submucosal scarring that can complicate the myotomy [5, 6]. Young patients and patients with an acceptable operative risk should be advised to consider surgical myotomy as an initial therapeutic procedure due to this fact.

12.3 Laparoscopic Heller Myotomy: Positioning and Anesthesia

The patient is placed on a split table with arms out and well padded to prevent brachial plexus injuries. The patient is well secured before being placed in steep reverse Trendelenburg position. Monitors are placed at eye level at the head of the operating table. The surgeon stands between the legs with the first assistant on the patient's left side.

12.4 Description of the Procedure

12.4.1 Port Placement

Initial insufflation is accomplished by insertion of a Veress needle at the midclavicular line in the left subcostal position. Pneumoperitoneum is established to 15 mmHg. A 5-mm optical viewing trocar is placed in this left subcostal position. If properly placed, this port can be used for the surgeon's right operating hand in the case. Under direct vision with a 30-degree laparoscope, a 5-mm port is placed about 10–15 cm below the base of the sternum, superior to the umbilicus, and directly in line with the esophageal hiatus. This will be the camera port. Additional 5-mm ports are placed about two fingerbreadths to the right of the xiphoid on the right costal margin (surgeon's left operating hand) and laterally on the patient's left abdomen (assistant's port for retraction). A 5-mm incision is made in the subxiphoid position for a Nathanson liver retractor for retraction of the left lobe of the liver. As described in the chapter on laparoscopic Nissen fundoplication, the entire operation can be conducted with 5-mm ports depending on the type of needle used for suturing. If a 10-mm suturing device or a curved needle that must be passed through a 10-mm port is used, the left midclavicular subcostal port can be upsized.

12.4.2 Hiatal and Esophageal Dissection

Dissection for Heller myotomy is typically performed with electrocautery or an ultrasonic dissector. The gastrohepatic ligament is divided and the base of the right crural pillar is identified. If a replaced left hepatic artery is encountered, it should be

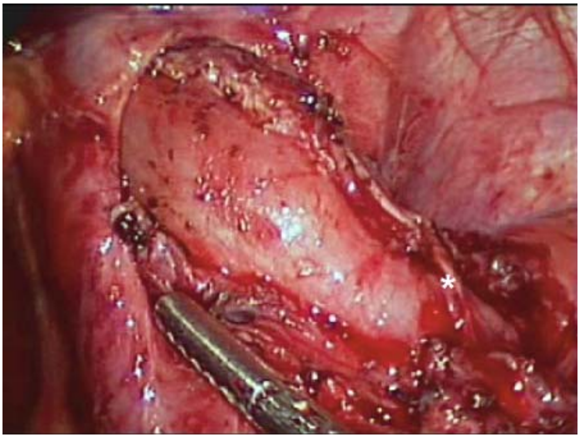

Fig. 12.1 Anterior vagus nerve (∗) crossing distal esophagomyotomy

preserved. At the base of the right crus, the phrenoesophageal ligament is divided. The assistant provides counter-traction by grasping the gastroesophageal junction fat pad and retracting caudally. The dissection proceeds anteriorly to the apex of the right crus and then the phrenoesophageal membrane on the anterior border of the left crus is gently dissected. If an anterior fundoplication (Dor) is to be used after the myotomy, an extensive posterior dissection is not necessary. If a posterior fundoplication is to be employed, a circumferential hiatal dissection should be performed. The anterior vagus nerve is identified and preserved. The anterior vagus nerve often crosses the most optimal anterior esophageal location for the myotomy and may need to be mobilized and reflected during the myotomy to avoid transaction (Fig. 12.1).

Mediastinal mobilization of the esophagus should continue until approximately 6 cm of anterior esophagus is accessible for the myotomy. We prefer to resect the anterior fat pad that lies over the GE junction to better identify this important transition from our intraabdominal extraluminal vantage point.

12.4.3 Myotomy

The myotomy is best begun on the anterior distal esophagus (Fig. 12.2).

We prefer to use a monopolar hook electrocautery instrument with the coagulation current set to 20 W and the cutting current set to 0 W. We carefully use a combination of short bursts of electrocautery and blunt dissection with the hook to separate first the longitudinal esophageal muscle fibers and then to hook, elevate, and divide the circular fibers. Once in the correct submucosal plane, the assistant grasps the left edge of the myotomy with a dissector and the surgeon grasps the right edge of the myotomy with his/her left hand and a similar laparoscopic dissector. The back elbow of the hook is used to create space in the submucosal plane

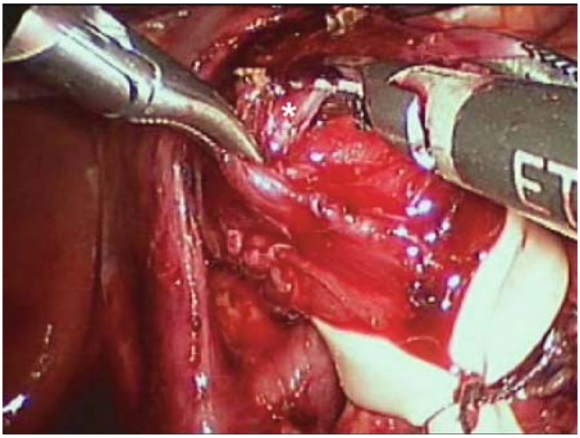

Fig. 12.2 The myotomy is started anteriorly and distally then carried proximally. Once in the correct plane between the submucosa and the circular esophageal muscle fibers (∗), the myotomy is easily extended proximally

before hooking the esophageal muscle fibers and lifting them away from the mucosa. Care should be taken to ensure that cautery is not applied to the mucosa. The anterior myotomy is continued cephalad for a length of 4–6 cm. The myotomy must then be continued onto the anterior gastric wall for a minimum of 2 cm. The orientation of the muscle fibers becomes more random and the myotomy is much more difficult to perform on the stomach, but an adequate gastric myotomy has been shown to be essential for long-term relief of dysphagia [7].

During the course of conducting the myotomy, bleeding from the divided muscle edges may occur. This is extremely common and typically self-limited. Bleeding can be controlled by gentle pressure with a sponge or an absorbable hemostatic material such as oxidized regenerated cellulose. Excessive use of cautery to control bleeding should be avoided so as not to damage the mucosa and cause either an immediate or a delayed perforation. If a mucosal perforation is identified, it should be repaired with fine sutures. We prefer 3-0 or 4-0 absorbable interrupted suture. If the mucosal perforation is on the distal esophagus, consideration should be given to covering this mucosal repair with an anterior fundoplication. If the mucosal perforation is too proximal on the esophagus to be covered by a fundoplication, consideration should be given to closing the esophageal muscle over the mucosal repair.

After completion of the myotomy, a diagnostic upper endoscopy is preformed. During passage of the endoscope, the GE junction is evaluated endoscopically and laparoscopically to ensure that the myotomy is complete and that it extends at least 2 cm onto the anterior gastric wall. The esophagus and stomach are insufflated with the mucosa under water to evaluate for air bubbles, signifying a mucosal perforation.

12.4.4 Fundoplication

Most surgeons perform some type of fundoplication following a Heller myotomy. A prospective randomized trial evaluating the outcomes following laparoscopic Heller

with and without an anterior fundoplication determined that the routine addition of a fundoplication is superior to Heller myotomy alone in regards to postoperative gastroesophageal reflux disease [8]. The two most common types of fundoplication following Heller myotomy are the Toupet 270-degree posterior fundoplication and the Dor 180-degree anterior fundoplication. Proponents of the posterior fundoplication believe that the fundus sutured to the divided muscle acts to hold the myotomy apart. An anterior fundoplication may prevent a delayed mucosal perforation or an unrecognized mucosal perforation from becoming clinically apparent. A Dor fundoplication is also easier and faster to construct than a Toupet. We routinely perform a Dor anterior fundoplication with laparoscopic Heller myotomy.

The esophageal hiatus is re-approximated posteriorly with permanent braided sutures. It is important not to impinge or angulate the esophagus with the hiatal closure. For the Dor fundoplication, dividing the short gastric arteries is not necessary. For the first stitch, the top part of the cardia is sutured to the anterior left crural pillar and to the left side of the myotomy at the most superior aspect (Fig. 12.3).

When placing this suture, it is important to place the suture in the portion of the myotomy that naturally sits next to the crural pillar to avoid angulating or kinking the esophagus in this area. The anterior surface of the gastric cardia and fundus are then folded upward and toward the patient's right placing the anterior gastric wall over the myotomy. The next stitch incorporates the anterior fundal flap, the right edge of the myotomy, and the anterior right crural pillar (Fig. 12.4).

Two more sutures are placed between the anterior fundus and the right edge of the myotomy, essentially covering the entire myotomy with anterior fundus. We use braided, permanent polyester 2-0 sutures to create the anterior fundoplication.

All port sites are infiltrated under direct vision with bupivacaine as local anesthetic. The 10-mm port in the left upper abdomen is closed with an Endoclose. The Nathanson liver retractor and ports are removed under direct vision to evaluate for bleeding. The patient's abdomen is desufflated and all incisions are closed.

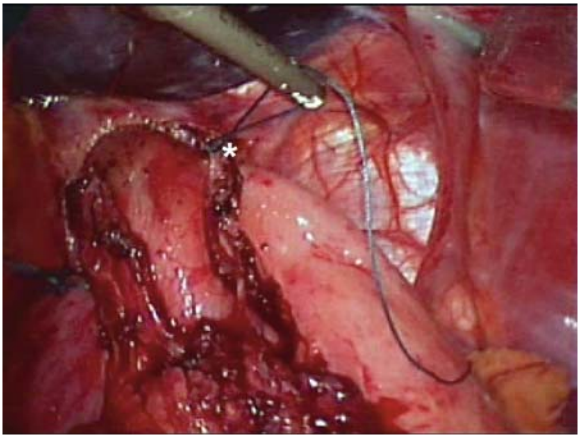

Fig. 12.3 The first stitch in the Dor anterior 180-degree fundoplication is a 3-point suture incorporating the left edge of the myotomy, the anterior fundus slightly lateral to the angle of His, and the left anterior crural pillar (∗)

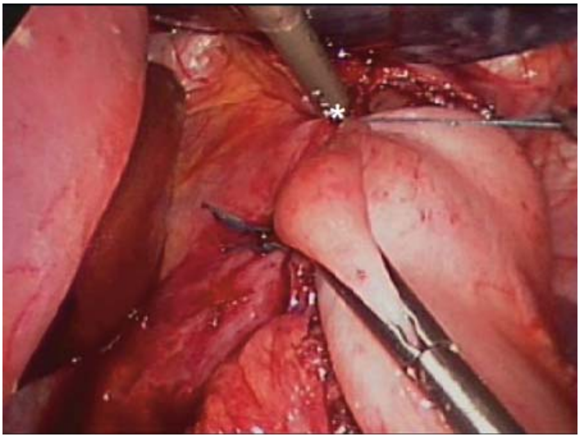

Fig. 12.4 The second stitch in the Dor fundoplication incorporates the right edge of the myotomy, the anterior fundal flap near the greater curve, and the anterior right crural pillar (*)

12.5 Postoperative Care

Oral intake can be initiated immediately in many patients. We typically begin with clear liquids and rapidly advance to a pureed diet for 2 weeks. Following uncomplicated cases, routine esophagrams have been demonstrated to have a poor positive predictive value for leak and are not necessary. Most patients are discharged on postoperative day #1.

12.6 Complications

Approximately 83–100% of patients feel symptom relief after the first year and 67–85% state sustained relief after more than 10 years [1]. Persistent dysphagia and gastroesophageal reflux (GERD) are the most common postoperative complaints. The presence of GERD is a result of the GE junction myotomy [9]. Persistent dysphagia may result from an incomplete myotomy or angulation and impaired esophageal drainage from the hiatal closure or the fundoplication.

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Chapter 13
Laparoscopic Roux-en-Y Gastric Bypass

Anna Ibele, Gretchen Beverstein, and Jon Gould

13.1 Introduction and Indications

Obesity is a major health problem in the United States. The Framingham Heart Study group recently published that the incidence of obesity (BMI >30) in men increased from 5.8 % in the 1950s to 14.8% in the 1990s and the incidence in women has increased from 3.9 to 14% in the 1990s [1]. Obesity is a contributing factor in multiple health conditions including type 2 diabetes mellitus, coronary artery disease, dyslipidemia, stroke, sleep apnea, osteoarthritis, and some cancers. Morbid obesity is not only costly in terms of a patient's overall quality of life, but also has important financial repercussions. A study of national costs attributed to an overweight body habitus (BMI 25-29.9) and obesity (BMI > 30) projected medical expenses due to these conditions to account for approximately 92.6 billion dollars in 2002 [2, 3].

Bariatric surgery has been shown to result in lasting and clinically significant results when performed on appropriate candidates. Roux-en-Y gastric bypass can result in 60–80% excess weight loss, which may lead to resolution of associated medical conditions such as hypertension, sleep apnea, and diabetes. A recent retrospective cohort study found that gastric bypass decreased a patient's adjusted long-term mortality by 40% and decreased mortality from diabetes by 92% [4].

Bariatric surgery should be considered for individuals who have failed multiple conservative attempts at weight loss and have a body mass index (BMI) of greater than 40 kg/m^2 (or BMI greater than 35 kg/m^2 with significant obesity-related medical comorbidities). Patients should possess a comprehensive understanding of the risks and benefits and be strongly motivated to succeed.

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13.2 Preoperative Evaluation

The screening process in our program is similar for all patients, regardless of desired procedure. Patients are extensively screened and educated about all aspects of bariatric surgery. A variety of relative psychiatric and psychological contraindications exist including active eating disorders as well as untreated or inadequately treated mental health issues and/or addictions. Medical contraindications may include severe cardiopulmonary disease, end-stage liver disease with cirrhosis, and severe inflammatory bowel disease, to name a few.

A variety of medical conditions are prevalent in morbidly obese patients and diligent screening is indicated in many potential patients. Obstructive sleep apnea is often unrecognized and if untreated can lead to severe cardiac and pulmonary complications following surgery. We administer a validated questionnaire and attain formal sleep polysomnography studies on high-risk patients. Screening for coronary artery disease and restrictive pulmonary disease is often necessary. Other specialists including endocrinologists and gastroenterologists are often asked to evaluate patients on a case-by-case basis, as well. Our protocol calls for patients to begin a high-protein, low-calorie liquid diet 2 weeks prior to surgery. It has been shown that this can lead to decrease in liver size and fat content, particularly in the left lobe [5]. This is of obvious benefit for a patient population with a high incidence of steatosis and hepatomegaly.

13.3 Positioning and Anesthesia

Patients undergoing laparoscopic gastric bypass surgery are at high risk for deep venous thromboembolism (DVT) and pulmonary embolism. DVT prophylaxis with subcutaneous heparin (unfractionated or low molecular weight heparin) 30 min prior to the induction of anesthesia should be the standard in all cases. Lower extremity sequential compression devices should also be on and operational prior to induction. Proper patient positioning on an appropriate table is critical to avoid injuries. Bariatric patients may be at higher risk for brachial plexus injuries, especially with prolonged cases. Arms should be padded and carefully secured. Arms should be flexed anteriorly when out at the sides on wedges to prevent brachial plexus stretch. Steep reverse Trendelenburg during certain phases of laparoscopic gastric bypass can be extremely helpful for exposure and the use of a foot board minimizes the chance of a patient sliding off the table. An anesthesia team that is experienced and comfortable intubating extremely obese patients with difficult airways using a variety of techniques is critical. We routinely administer a dexmedetomidine infusion (Precedex, Hospira, Lake Forest, IL) beginning 30 min before the anticipated completion of the procedure and in the recovery room. Dexmedetomidine is an alpha-2 receptor agonist with sedative- and analgesic-sparing properties. We have found that patients who receive this infusion require less narcotic pain medication for pain control after surgery and are discharged to home sooner following laparoscopic gastric bypass [6].

13.4 Description of the Procedure

A variety of different techniques exist for Roux-en-Y laparoscopic gastric bypass. The most common variations relate to the position of the Roux-limb and the technique used to create the gastrojejunostomy. The Roux-limb can be placed anterior to both the colon and the gastric remnant, posterior to the colon and anterior to the gastric remnant, or posterior to both. When the Roux-limb is placed posteriorly, the distance to the gastric pouch is shorter, theoretically decreasing tension on the gastrojejunostomy, especially in very obese patients. Placing the Roux-limb in a posterior location unfortunately also creates an additional space for an internal hernia. The gastrojejunostomy is most often constructed using surgical staplers (either circular staplers or linear staplers) or using hand-sewn techniques with sutures. There are advantages and disadvantages to each technique and experienced surgical teams can achieve good safe outcomes in a timely manner with all of these methods. Our standard technique at the University of Wisconsin involves the antecolic, antegastric placement of the Roux-limb. The gastrojejunostomy is constructed with a circular stapler and the anvil is placed into the pouch transgastrically.

13.4.1 Port Placement

We employ a five-port (six incisions) technique for laparoscopic Roux-en-Y gastric bypass. Initial abdominal access is obtained using a 5-mm optical viewing trocar in the left paramedian supra-umbilical location. This port will be used for the laparoscope. The most common error is to place this port too low to visualize the very proximal gastric pouch. In patients with a very high BMI and thick abdominal wall, a 10-mm port is placed in this location so that a larger laparoscope can be used. We have bent several 5-mm scopes in extremely obese patients. Pre-insufflation with a left subcostal midclavicular Veress needle makes initial placement of this port safer. A 10-mm port is placed in the right subcostal area close to the midline. This is positioned at the inferior edge of the liver, as far to the right as possible while still staying to the left of the falciform ligament. An additional 5-mm port is then placed on the right side of abdomen about a hand's breadth caudal and slightly lateral to the right subcostal 10-mm port. The fourth port is a left subcostal 10-mm port placed in midclavicular line. This port is triangulated with the 10-mm right subcostal port and the camera port in the paramedian location for working near the gastroesophageal junction. The fifth port is placed on left side of abdomen as laterally as possible avoiding the splenic flexure of colon or omentum. Our laparoscopic gastric bypass technique involves the transgastric placement of a circular stapler anvil. This left-sided lateral port is the location through which the anvil and the circular stapler will be passed. A larger fascia defect is desirable in this location and a 15-mm dilating or a 12-mm bladed trocar can be used here to facilitate these maneuvers. The first assistant stands on the patient's left side and holds the camera with his/her left hand and assists through the left lateral port with his/her right hand. The surgeon stands

on the patient's right side. For the creation of the Roux-limb, the surgeon works through the two right-sided ports. During the creation of the gastric pouch and gastrojejunostomy the surgeon operates through the right subcostal and midclavicular left subcostal ports.

13.4.2 Creation of Roux-limb

We routinely create the jejunojejunostomy and Roux-limb as the initial step. The omentum is reflected cephalad and tucked beneath the left lobe of the liver. The ligament of Treitz is identified at the base of the transverse mesocolon. The assistant grasps the mesocolon anterior to Treitz and lifts the mesocolon straight anteriorly to facilitate this step. The ligament of Treitz is clearly identified and the bowel is run for 50 cm. In this location, the jejunum is transected using an endoscopic linear cutting stapler. In profoundly obese patients, we sometimes create a longer biliopancreatic limb and go more distal on the proximal jejunum before dividing the bowel. This can help the Roux-limb to reach the proximal gastric pouch with less tension in these cases. The mesentery between each segment is divided for about 2 cm with an ultrasonic dissector. The Roux-limb length is determined by the patient's BMI: 100 cm for a BMI < 50 kg/m^2 and 150 cm for a BMI > 50. The jejunum in the downstream location is then anastomosed to the proximal biliopancreatic limb. A single 2-0 silk stay suture is placed in the anti-mesenteric portion of each segment of jejunum. Enterotomies are created in each segment with the ultrasonic shears. An endoscopic linear cutting stapler of 60 mm length is inserted down each lumen and fired, creating a side-to-side functional end-to-end jejunojejunostomy (Fig. 13.1). The internal anastomosis is inspected for hemostasis. The opening in the bowel is closed with an additional load of the endoscopic linear cutting stapler, taking care not to compromise the caliber of the lumen of the jejunojejunostomy.

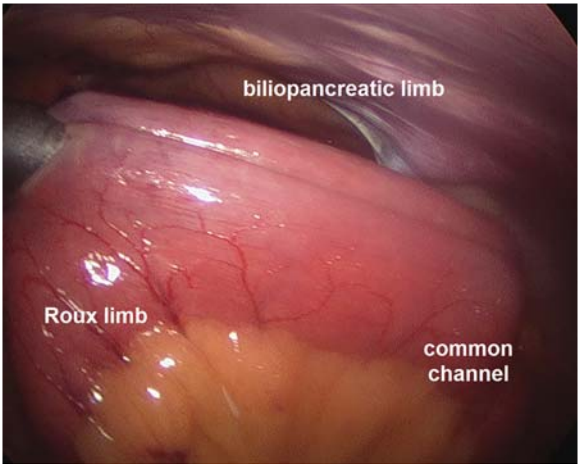

Fig. 13.1 Stapled jejunojejunostomy

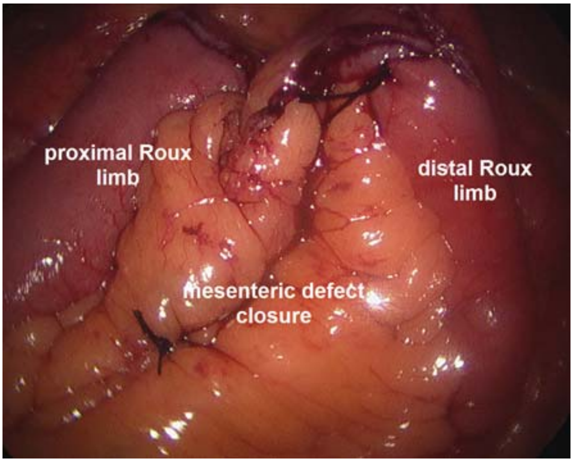

Fig. 13.2 Sutured closure of jejunojejunostomy mesenteric defect

The mesenteric defect is then closed with a running locking 2-0 silk suture from the anastomosis to the base of the mesentery (Fig. 13.2). Closing Peterson's space (between the mesentery of the Roux-limb and the mesocolon, transverse colon, gastrocolic omentum, and anterior stomach when an antecolic and antegastric technique is employed) is extremely difficult and is not a part of our routine. We split the omentum up the middle from the mid-transverse colon using an ultrasonic shears. The Roux-limb is brought anterior to the mid-transverse colon and into the proximal abdomen between the leaves of the omentum.

13.4.3 Creation of the Gastric Pouch

The patient is positioned in steep reverse Trendelenburg at this time to facilitate exposure of the proximal stomach. A Nathanson liver retractor is inserted through a subxiphoid 5 mm incision and secured with a mechanical arm retractor. The Nathanson retractor is used to lift the left lobe of the liver anteriorly. Care should be taken not to crack, especially, heavy and fatty livers with this retractor during placement. We start by dissecting the gastroesophageal junction fat pad off the left crus of the diaphragm at the angle of His. This makes later visualization of the proximal stomach during gastric pouch creation a bit easier. We then dissect between the proximal lesser curve gastric wall and the lesser curve neurovascular bundle and into the lesser sac. This location is typically between the fat pad and the first lesser curve vessel visible on the anterior proximal stomach (about 2 cm distal to gastroesophageal junction). This marks the distal lesser curve margin of the gastric pouch to be created after placement of the circular stapler anvil. A gastrotomy is made on the mid-greater curve of the stomach for placement of the circular stapler anvil. A silk suture is tied to the tip of a 25-mm circular stapler anvil. We have used both a 21- and a 25-mm anvil and in our experience the use of a larger anvil is associated with a lower incidence of gastrojejunostomy stenosis without compromising

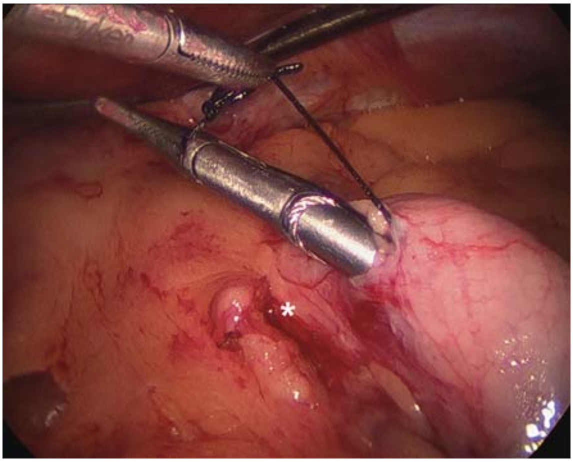

Fig. 13.3 Transgastric placement of circular stapler anvil. The intragastric dissector is articulated within the stomach proximal to the lesser curve tunnel (*) and just distal to gastroesophageal junction

weight loss [7]. The suture on the anvil is grasped with a fine laparoscopic dissector designed to articulate 90°. The dissector is passed through the greater curve gastrotomy and the instrument is articulated intragastrically once the tip is proximal to the lesser curve window into the lesser sac created earlier. Cautery or an ultrasonic shears is used to open the proximal anterior gastric wall on the tip of the dissector and the silk suture is retrieved from the jaws of the articulating grasper (Fig. 13.3). The silk is pulled until the circular stapler anvil is seated completely in the proximal stomach. The greater curve gastrotomy is closed with a linear cutting stapler. The gastric pouch is then created using the window into the lesser sac for the first load of the linear cutting stapler. After the first application of the stapler perpendicular to the lesser curve, the remaining linear cutting stapler loads necessary to create the gastric pouch are applied parallel to the lesser curve (Fig. 13.4). Division of the

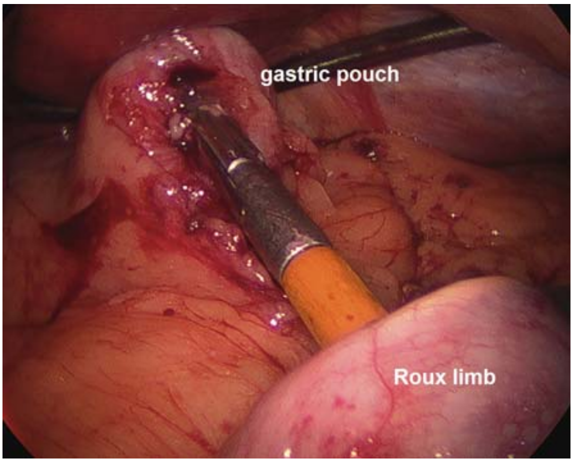

Fig. 13.4 Circular stapler and anvil engaged and ready to create gastrojejunostomy

pouch from the remnant stomach must be complete or a gastro-gastric fistula can result. This may impair weight loss and lead to anastomotic ulcers. In very obese patients, this is an especially difficult area to visualize. Once completely divided, a gastric pouch of approximately 15–20 mL is the result. The spike to the anvil protrudes out the distal anterior pouch wall and the anvil itself resides in the lumen of the gastric pouch.

13.4.4 Creation of the Gastrojejunostomy

The Roux-limb is opened at the staple line. The left-sided abdominal wall incision is dilated at the fascia level and the circular stapler is passed through the abdominal wall. The end of the stapler is inserted into the Roux-limb for approximately 5–10 cm and the spike on the stapler is passed through the anti-mesenteric border of the Roux-limb. The spike on the stapler and the anvil in the gastric pouch are engaged and the circular stapler is fired. Care must be taken during this step to ensure that the pouch is not twisted and that the remnant stomach does not wander between the stapler and anvil and become involved in the circular staple line. The open end of the Roux-limb is closed by firing a linear cutting stapler flush with the left side of the gastrojejunostomy and the lateral border of the pouch. If excess jejunum is left proximal to the gastrojejunostomy, this blind end can dilate over time, fill with food, and cause symptoms as it distends and periodically decompresses. We routinely over-sew the gastrojejunostomy with 2-0 absorbable sutures. The use of absorbable rather than permanent sutures at the gastrojejunostomy may help to minimize the incidence of marginal ulcers [8]. A leak test is performed by passing an orogastric tube into the Roux-limb and forcefully injecting air with a 60 mL syringe. If air bubbles are identified, the leak should be repaired immediately with sutures. We do not routinely place drains or tubes except in complicated cases. If non-bladed dilating ports have been placed, the only port site requiring closure at the fascia level is the left-sided port through which the circular stapler and anvil were passed. A suture passer and large caliber absorbable sutures can be used to close the fascia. Local anesthesia is attained with 0.25% bupivacaine. All ports are removed under direct visualization to ensure that there is no abdominal wall bleeding. The air is released from the peritoneal cavity and all skin incisions are closed with absorbable subcuticular sutures.

13.5 Intraoperative Considerations

13.5.1 Gallbladder

The approach to the gallbladder at the time of laparoscopic gastric bypass varies from surgeon to surgeon, and a clear consensus does not exist. Options for those patients who still have their gallbladder at the time of gastric bypass (22% of UW

laparoscopic gastric bypass patients have previously undergone cholecystectomy) include routine cholecystectomy in all patients, cholecystectomy if preoperative or intraoperative evaluation reveals gallstones, or no concurrent cholecystectomy except in unusual circumstances. There are advantages and disadvantages to each approach. In our program, we do not screen for gallstones preoperatively and instead visually inspect the gallbladder at the time of surgery. If there is obvious pathology, the gallbladder is removed at the time of laparoscopic gastric bypass. Otherwise, we typically place patients on ursodiol for 6 months following surgery to minimize the chances of new gallstones forming during the rapid weight loss phase.

13.5.2 Hernias

Most abdominal wall hernias identified prior to or at the time of gastric bypass should be repaired. There is a high incidence of acutely incarcerated hernias if these are not addressed at the time of surgery [9]. In our personal experience, umbilical hernias have a high rate of acute incarceration and obstruction of the Roux-limb in the immediate perioperative period, perhaps due to the antecolic, antegastric position of the Roux-limb using our technique. Primary repair or laparoscopic repair using a biologic prosthetic should be considered in most patients.

13.5.3 Severe Obesity

In extremely obese patients (BMI >> 60 kg/m^2), especially in patients with predominantly central obesity, it may be difficult or even impossible to complete the operation laparoscopically. There are several techniques, which can be used to complete the case, depending on each surgeon's comfort level and experience. A longer, lesser curve-based tubular pouch may help the Roux-limb to reach the proximal abdomen with less tension [10]. Another option is to perform a sleeve gastrectomy, either as a stand-alone bariatric operation or as the first stage of a two-staged laparoscopic gastric bypass [11]. Yet another choice is to insert a hand port in the midline and complete the case in a hand-assisted fashion [12]. Laparoscopic gastric bypass on the super-super obese patient population is extremely challenging and complication rates can be higher. These cases are best left to very experienced surgical teams.

13.6 Postoperative Care

Patients are admitted to the hospital postoperatively for at least one night of observation. Specialized bariatric beds should be used for appropriate patients (all patients with BMI >55 kg/m^2 in our practice). Wide doors, floor mounted toilets,

and appropriate bariatric equipment is important for patient and provider safety. Bariatric patients are at increased risk for DVT/PE and postoperatively, early ambulation is encouraged. In our practice, patients with a BMI > 50 kg/m^2 and those with additional risk factors are discharged on 2 weeks of home low molecular weight heparin injections. Routine upper GI swallow evaluation is not necessary [13]. In reasonable-risk patients with a negative intraoperative leak test and an uncomplicated procedure, we typically initiate the diet on the afternoon of the day of surgery, with absent nausea or other limiting factors or symptoms. Patients are usually discharged to home within 24–48 h post-procedure provided they are tolerating their pureed/soft diet, they are well hydrated with good urine output, they have a stable hematocrit, and they are not tachycardic compared to their preoperative baseline heart rate.

13.7 Complications

A variety of complications can occur after laparoscopic gastric bypass. Data has demonstrated that these complications occur less frequently in the hands of an experienced surgical team [14]. Leak is a dreaded complication of gastric bypass. Early leaks can be subtle and difficult to detect, but early identification and treatment is essential to avoid significant resultant morbidity and mortality. The incidence of leak following laparoscopic gastric bypass is roughly 1–2% [15]. Tachycardia and a fluid deficit that is difficult to correct are sensitive, although not entirely specific early indicators of a leak. Gastrointestinal or intraabdominal bleeding can also occur, especially in patients who are anticoagulated, out of a justified concern for potential DVT/PE. Late complications include marginal ulceration, gastrojejunostomy stenosis, and internal hernia. Vitamin and mineral deficiencies, especially iron, vitamin B12, Vitamin B1, and calcium are also possible after gastric bypass. For these reasons and others, long term and longitudinal care in a bariatric program are important for durable and safe results following surgery.

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Chapter 14
Esophagectomy

James D. Maloney and Tracey L. Weigel

The incidence of esophageal adenocarcinoma continues to increase, and survival remains poor in comparison to other stage-matched malignancies. Early detection and aggressive intervention are demonstrated to provide optimal results for patients who have early esophageal cancer or Barrett's esophagus with high-grade dysplasia [1]. Mortality statistics for esophageal resection in institutions with low volume have led to comparisons showing significantly improved mortality in institutions with high volume [2]. Morbidity, however, remains high at most centers and has provided the impetus for adopting a minimally invasive surgical (MIS) approach. Development of laparoscopic and thoracoscopic techniques for fundoplication, giant paraesophageal hernia repair, and esophageal myotomy and pulmonary lobectomy have given surgeons the tools necessary for MIS esophageal resection. MIS techniques developed for benign esophageal pathology have been refined and now are applied selectively to patients who have malignant esophageal disease. Esophagectomy is also the treatment of choice in Barrett's esophagus or metaplasia of the squamous epithelium at the GE junction, once high-grade dysplasia (HGD) has developed. Endoscopic therapies have been advocated for early malignant and premalignant disease in patients who are not candidates for surgery. Controversy remains regarding the use of endoscopic treatments in patients who are operative candidates. Endoscopic ultrasound (EUS) has become a mainstay in the workup of esophageal cancer and is now advocated as confirmation that endoscopic ablative therapy is appropriate. The potential for under-staging exists in these patients as EUS in combination with other radiologic studies may miss malignant adenopathy [3]. Pathologic specimens do not include lymph node analysis in endoscopic therapy. Minimally invasive esophagectomy (MIE) maintains the oncologic principles of resection and pathologic staging while reducing the associated morbidity.

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14.1 Open Esophagectomy

The two most frequently performed operations are the transthoracic esophagectomy (TTE) and the transhiatal esophagectomy (THE). Transhiatal esophagectomy was popularized by Orringer at the University of Michigan. This approach avoids thoracotomy and involves a cervical esophagogastric anastomosis, with the purported advantage of pain reduction, subsequently minimizing respiratory complications [4]. Exposure consists of laparotomy and left neck incision. Conservative management of anastomotic leak with minimal morbidity has been a hallmark of THE. Recently, authors have questioned the belief that anastomotic leak in the chest has a higher mortality if adequate drainage is achieved [5]. An Ivor-Lewis TTE approach includes a thoracotomy in addition to a laparotomy. The former enables esophageal mobilization under direct vision and an extended lymphadenectomy with an intrathoracic anastomosis. Disadvantages include increased incisional pain with potentially greater respiratory complications and greater potential morbidity from an intrathoracic anastomotic leak [6]. Recent comparison in a large meta-analysis has shown no significant differences in mortality and morbidity between the two approaches [7]. Exposure of the esophagus through the right chest is excellent up to and above the azygous vein, but a neck incision may be necessary in some patients who have more proximal disease. Neither approach has been shown to have a superior oncologic outcome, as overall survival is the same [8].

14.2 Minimally Invasive Esophagectomy (MIE)

This approach has increased in use in the thoracic surgical community significantly in recent years. MIE can be performed with either a cervical or intrathoracic anastomosis. All or part of the procedure may be performed in a minimally invasive manner. The authors have applied minimally invasive techniques in a selective way based on pathology and patient anatomy. Thoracoscopic esophagectomy, laparoscopic gastric mobilization, and cervical esophagogastrostomy, however, have been their most common approaches in patients who have early malignant and premalignant disease. There has been an evolution in the approach to minimizing morbidity from esophagectomy; first with THE, then minimally invasive surgery. As minimally invasive techniques have progressed, there has been a resurgence of interest in intrathoracic anastomosis accomplished with a thoracoscopic exposure. The strength of the MIS approach is that the extent of resection and ability to assess adenopathy or other potential sites of disease remains intact.

14.3 Indications for Minimally Invasive Esophagectomy

At the University of Wisconsin, we have used MIE in various stages of disease. It is the procedure of choice in patients who have Barrett's esophagitis

with high-grade dysplasia and T1 (carcinoma invading the lamina propria or submucosa) or T2 (carcinoma invading the muscularis propria) tumors without evidence of adenopathy. Neoadjuvant therapy is not an absolute contraindication to a minimally invasive approach. The authors, however, would not recommend a completely minimally invasive approach in a suspected T4 (carcinoma invading local structures) tumor. Multiple previous abdominal procedures and other anatomic considerations may deter from a totally endoscopic approach and favor a laparotomy rather than laparoscopy for the abdominal nodal dissection and gastric conduit creation. This example emphasizes the need for selective approach in which minimally invasive techniques should be tailored to individual patients. Patients must have adequate cardiac and pulmonary reserve to proceed with either MIE, TTE, or THE, and these parameters do not differ from patients planned for an open esophagectomy. Reversible ischemia on nuclear study or evidence of congestive heart failure despite appropriate medical therapy would preclude patients from surgery. Patients who have reduced functional expiratory volume (FEV1) in combination with other comorbid medical conditions have an increased risk of cardiac arrhythmia and respiratory complications. Careful patient selection is appropriate for all esophagectomies, whether open or minimally invasive.

14.4 Minimally Invasive Esophageal Resection Techniques

14.4.1 Thoracoscopic Esophageal Mobilization

With a totally endoscopic, McKeown approach, thoracoscopic mobilization of the esophagus and mediastinal nodal dissection are the initial steps. The patient is intubated with a double-lumen endotracheal tube for selective left lung ventilation. The patient is placed in the left lateral decubitus position with his or her arms in the praying position, supported with pillows or arm board on a beanbag mattress with the table flexed at the level of the anterior superior iliac spine. Accurate thoracoport site placement is integral for effective esophageal mobilization. Four working ports are used. A 10-mm camera provides optimal lighting and visualization. This port is placed in the seventh intercostal space. Posteriorly, two 5-mm ports are inserted and available for both retraction and dissection with the ultrasonic coagulating shears immediately posterior to the tip of the scapula and approximately 5 cm caudal to this in the posterior axillary line. A second 5-mm port is inserted in the fifth intercostal space posteriorly, just below the tip of the scapula. A 5-mm port is placed anteriorly in the fourth space for lung and esophageal retraction (Fig. 14.1). Once port access is obtained, the patient is rotated slightly prone and the right lung is retracted superiorly as the inferior pulmonary ligament divided. The mediastinal pleura is divided along the anterior border of the esophagus, posterior to the pulmonary vein, elevating the esophagus off the left atrium. The periesophageal (level #8), inferior pulmonary ligament (level #9), and subcarinal (level #7) nodal packets are easily

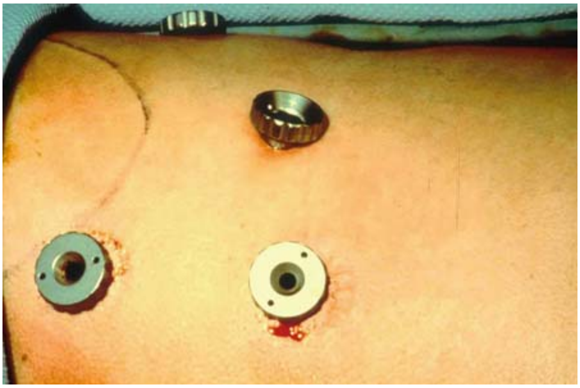

Fig. 14.1 Left lateral decubitus position. Four ports located to optimize VATS esophageal mobilization

and completely dissected out thoracoscopically with this approach. The pleura overlying the posterior border of the esophagus then is incised anterior to the azygous vein and the esophagus is mobilized circumferentially. A Penrose drain then can be placed around the esophagus and stapled into a small loop to facilitate esophageal retraction out of the mediastinum. The azygous vein is divided near the junction with the superior vena cava with a vascular load of the Endo-GIA vascular stapler (Endo-GIA II, Covidien, Norwalk, Connecticut). Wide excision of the esophagus, pleura, and mediastinal nodes is performed up to and including the carina nodal region. Cephalad to this point dissection is kept close to the esophagus to avoid the posterior membranous trachea. Most dissection is accomplished with ultrasonic coagulating shears. Dissection continues to the thoracic inlet and the Penrose drain is left around the esophagus and tucked up into the left neck, which facilitates the cervical esophageal dissection later on. The superior mediastinal (level #4) lymph nodes also are easily dissected out after division of the azygous vein. A single chest 28 French chest tube or 24 French Blake drain is left for drainage through the anterior seventh intercostal thoracoport site. The remaining incisions are closed with absorbable sutures after local anesthesia is achieved with intercostal nerve blocks with 0.25% bupivacaine.

If the anastomosis is planned in the thoracic cavity, the laparoscopic portion described below is completed first. Typically, the intrathoracic anastomosis is created in a stapled fashion. A 28-mm circular stapler or a 30-mm Endo-GIA stapler (Covidien) may be used. The Endo-GIA stapler is inserted through a 10-mm port. Anterior extension of the lower, posterior axillary line port site incision is necessary for insertion of the circular stapler because of its larger diameter. When using the Endo-GIA, the anastomosis is fashioned in a side-to-side functional end- to-end manner between the posterior wall of the esophagus and anterior wall of the gastric conduit, as popularized by Orringer in cervical anastomosis (Fig. 14.2). A double -staple technique or suture closure is used to complete the anterior wall of the esophagogastric anastomosis. Robotic-assisted techniques with a sutured anastomosis have been reported and may be helpful in completing the anastomosis in a

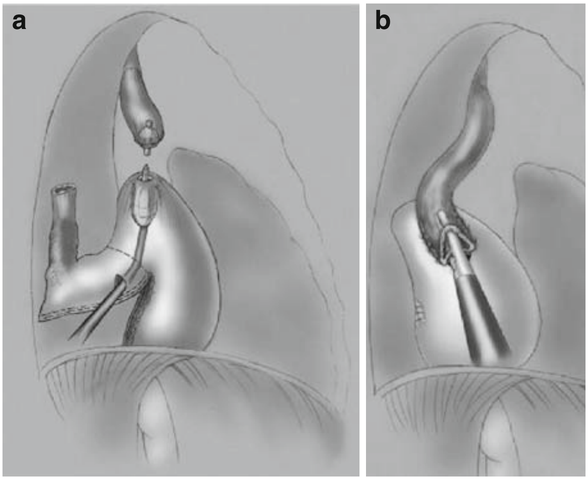

Fig. 14.2 A. EEA intrathoracic anastomosis. Gastric tube completed after anastomosis is performed (this figure should only have the first picture, B is separate). B. Endo GIA intrathoracic anastomosis performed after gastric tube is completed. Anterior portion closed with additional staple line or suture closure

side-to-side stapled technique [9]. With the EEA stapler the anvil is inserted through the extended port and placed within the open lumen of the divided proximal esophagus. A purse string suture is placed to secure the anvil within the esophagus. The circular stapler is advanced though the side of the gastric conduit, exiting anteriorly close to the apex. After the stapler is fired, it is imperative to have two complete donut rings within the device from the conduit and the esophagus. The lateral entry site for the circular stapler in the gastric conduit then is closed with the Endo-GIA stapler. Chest drainage is accomplished with a Blake drain and a standard right-angled chest tube along the posterior border of the esophagus.

14.4.2 Laparoscopic Gastric Mobilization and Conduit Preparation

At the University of Wisconsin, the authors use a similar approach to that described by Luketich and colleagues [10]. The patient is placed in a supine position. The authors do not use lithotomy or Nissen table position for the surgeon to stand between the legs. The surgeon stands on the patient's right and the assistant stands on the left. Five port sites are inserted: two paramedian 10-mm ports, and three additional 5-mm ports are placed in bilateral subcostal midaxillary lines and right flank position just below the tip of the 10th rib at approximately the anterior axillary line. The left lobe of the liver is retracted to expose the esophageal hiatus using a flexible retractor and held in place with a self-retaining system (Fig. 14.3).

Steep reverse Trendelenburg positioning with a footboard in place provides added exposure of the upper abdomen. The ultrasonic coagulating shears is the principle tool for dissection. The lesser sac is entered by dividing the gastrohepatic ligament and the right crus of the diaphragm is identified (Fig. 14.4). At this time, nodal tissue seen on CT scans or positron emission tomography (PET) may

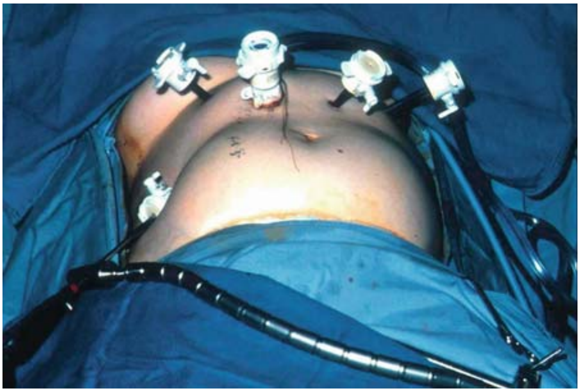

Fig. 14.3 Abdominal port site positions with liver retraction using Mediflex retractor. Two paramedian 10-mm ports and three additional 5-mm ports in bilateral subcostal position and right flank

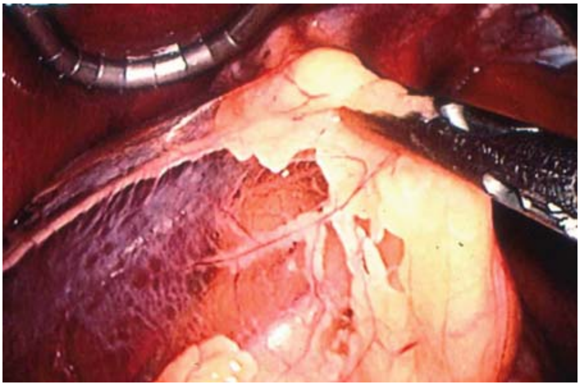

Fig. 14.4 Opening gastrohepatic ligament to assess resectability and mobilize lesser curvature of stomach

be sampled along the common hepatic artery or near the left gastric artery. Next we identify and preserve the right gastroepiploic artery, divide the gastrocolic ligament, and continue caudal to the vessel along the greater curve of the stomach to the duodenum. A formal Kocher maneuver to mobilize the duodenum is not necessary and rarely performed. The short gastric vessels are divided with the ultrasonic shears and dissection continues superiorly to the left crus. The stomach is retracted superiorly, for visualization of the left gastric artery. Nodal dissection at the base of this vessel down to the celiac artery is performed before division of the vessel, reflecting the nodal packet up onto the specimen by incising the peritoneum (Fig. 14.5). The left gastric artery and vein then are divided simultaneously with the Endo-GIA vascular stapler. Division of the bridging omental vessels at the right anterior aspect of the gastrocolic omentum provides additional length and mobility of the conduit. Pyloroplasty or pyloromyotomy is not performed routinely. The gastric conduit then is created using an Endo-GIA 3.5 or 4.8 mm load; the latter is used if the stomach is

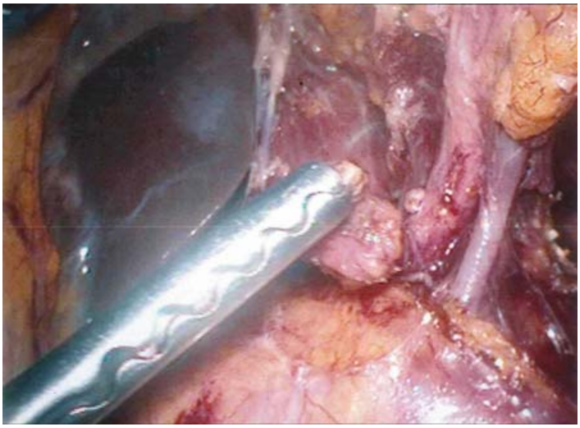

Fig. 14.5 Lymph node dissection around the gastric artery

thickened secondary to neoadjuvant chemoradiation. The right gastric artery is preserved (Fig. 14.6). The staple line is completed, staying parallel to the greater curve with a conduit width of approximately 5 cm. The gastric conduit then is sutured to the esophagogastric specimen. A 7 French needle jejunostomy tube is placed for

Fig. 14.6 Inspection of vascular pedicle supplying gastric conduit

feeding. The selected loop of jejunum is attached to the anterior abdominal wall with suture. A needle catheter kit is inserted percutaneously into the peritoneal cavity. Under laparoscopic guidance, it is directed into the proximal loop of jejunum. The guide wire and catheter are threaded into the jejunum using the Seldinger technique. The jejunum is tacked to the anterior abdominal wall with a total of three sutures around the jejunostomy tube entry site and an additional stitch a few centimeters distally to prevent torsion of the efferent jejunal limb. The feeding tube is secured to the skin with two 2-0 nylon sutures. Finally the phrenoesophageal ligament is incised circumferentially across the anterior surface of the esophagus and down the left crus. The dissection is carried up the hiatus after dividing a few slips of the right crus. If this is done before this point, pneumoperitoneum may be difficult to maintain. The Achilles heal of esophagectomy is the gastric conduit and if there is any question of compromise, conversion to open laparotomy is warranted.

14.4.3 Cervical Anastomosis

A curvilinear incision is made transversely across the base of the neck, running up the left sternocleidomastoid muscle for a total length of approximately 5 cm. The dissection is carried anterior to the carotid sheath down to the cervical spine. This dissection is facilitated by the pneumomediastinum and the Penrose encircling the esophagus is easily retrieved and used to deliver the esophagus into the field. The specimen is removed through this cervical incision. The conduit is advanced up the mediastinum under direct, laparoscopic vision as the esophagogastrectomy specimen is retrieved from the neck. A cervical esophagogastrostomy then is completed in the standard fashion. A stapled side-to-side functional end-to-end anastomosis is performed or alternatively a hand-sewn anastomosis with 4-0 Vicryl in a single interrupted transmural layer.

14.4.4 Results of Minimally Invasive Esophagectomy

A large meta-analysis review was performed demonstrating the widening application of minimally invasive approaches to esophagectomy. Twenty-three articles concerning the topic met the stringent requirement for review and included 1398 patients. Overall mortality (2.3%), morbidity (46%), and leak rate (7.7%) were similar to open procedures and confirm the safety and feasibility of the technique. Lymph node yield for an R0 resection (complete surgical excision) for these patients was similar to published results of open series [11]. Long-term follow up is needed to confirm that these values translate into satisfactory oncologic outcomes. Initial reports related to survival (3 years) suggest that it is comparable to open surgery in a highly selected group [12]. Adequate randomized data is not currently available to statistically confirm quality-of-life improvement from a minimally invasive approach in direct comparison with open approaches. Some authors believe that the improved quality of life after minimally invasive resection techniques may be best with a high thoracic anastomosis [13].

14.4.5 Oncologic Perspectives

Survival data for patients undergoing MIE appear similar to standard open approaches. Additional data are necessary for survival and cancer-free survival after endoscopic therapy for malignant and premalignant disease of the esophagus. At present, esophagectomy remains the gold standard for treating early esophageal cancer and Barrett's esophagus with HGD in patients who are appropriate candidates for surgery. Quality of life as measured by the Short Form 36 (SF-36) obtained after esophagectomy demonstrated that increasing cancer risk is associated with decreased health-related quality of life [14]. Uncertainty over ongoing cancer risk, emphasized by the rigorous follow-up needed following endoscopic therapy, may affect patients' sense of well being and reduce quality of life. A minimally invasive approach allows for complete resection and complete pathologic assessment.

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Chapter 15
Gastric Resection

Anna Ibele and Jon Gould

15.1 Peptic Ulcer Disease

15.1.1 Surgical Indications and Evaluation

The term peptic ulcer disease refers to both gastric and duodenal ulcers. Despite this fact, ulcers in either location can vary widely in terms of pathophysiology and treatment. Peptic ulcers may present with epigastric pain, bleeding (acute GI bleed with hematemesis or chronic anemia), perforation, or obstructive symptoms (for pre-pyloric and duodenal ulcers). The most common causes of peptic ulcers are infection with *H. pylori* and frequent use of aspirin or other nonsteroidal anti-inflammatory drugs (NSAIDs). Smoking can be an exacerbating factor in peptic ulcer disease. Gastric ulcers are more likely to be cancerous than duodenal ulcers and endoscopic biopsy is indicated, especially for gastric ulcers that are very slow to heal.

For elective and chronic cases of peptic ulcer disease, evaluation includes endoscopy (with biopsy in gastric ulcers to rule out cancer). Upper GI series can be of additional value, especially in cases of gastric outlet obstruction due to duodenal and pre-pyloric scarring/narrowing. *H. pylori* infection can be diagnosed with a breath test, a stool sample, by serology, or via antral biopsy attained on endoscopy. A variety of *H. pylori* eradication regimens exist and re-infection is uncommon. With proper *H. pylori* antibiotic treatment, the majority of peptic ulcers will heal. In cases with multiple ulcers or ulcers in unusual locations that prove difficult to treat medically, serum gastric levels as a screening test for a gastrinoma may be indicated. A bleeding ulcer in a stable patient should be evaluated and possibly treated with endoscopy. Perforated ulcers present with free intraperitoneal air and peritonitis. Little evaluation outside of an upright chest film is necessary in these cases before heading to the operating room for treatment.

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15.1.1.1 Perforated Peptic Ulcer

Despite the fact that the incidence of chronic peptic ulcer disease has declined in the past few decades, the overall rate of duodenal ulcer perforations does not appear to have changed. Increasingly, older patients with co-existing diseases are affected. Patients typically present with acute onset of abdominal pain and tachycardia. Free air on plain upright chest radiographs is often noted. In more subtle cases or in complicated cases in patients with multiple co-existing medical conditions, a CT scan may demonstrate free air or even thickening of the duodenum with associated inflammatory changes. In nearly all cases, the management of these ulcers is operative. Occasional reports have advocated non-operative management, although the potentially significant consequences of delayed surgical therapy limit this approach to the small subset of patients with already sealed perforations who are clinically stable at the time of diagnosis.

In the current era, Graham patch closure of all but the largest perforations is the appropriate management. For surgeons with a high degree of comport with laparoscopic suturing techniques, laparoscopic Graham patch closure of a perforation is appropriate and may result in decreased patient morbidity [1]. The majority of perforations result in defects less than 1 cm diameter and in the anterior portion of the first portion of the duodenum (Fig. 15.1). A classic Graham patch involves plugging a piece of healthy local omentum into the perforation to seal the hole. An absorbable suture (2-0 Polyglactin 910 on an SH needle) is passed through healthy duodenal tissue on each side of the perforation and the omentum is pulled into the loop and secured by tying the knot. Care must be taken not to tie the knot too tight such that the blood supply to this piece of omentum is compromised. The duodenal tissue next to the ulcer may be quite friable, so advanced knot tying skills with attention to proper distribution of tension during knot tying is critical. Two or three sutures are sufficient for most ulcers (Fig. 15.2). Fibrin glue can be used to strengthen the closure according to surgeon preference. The use of a low suction

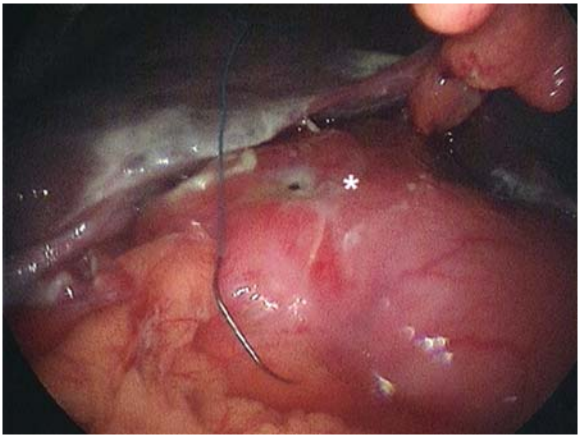

Fig. 15.1 Anterior duodenal ulcer perforation (∗)

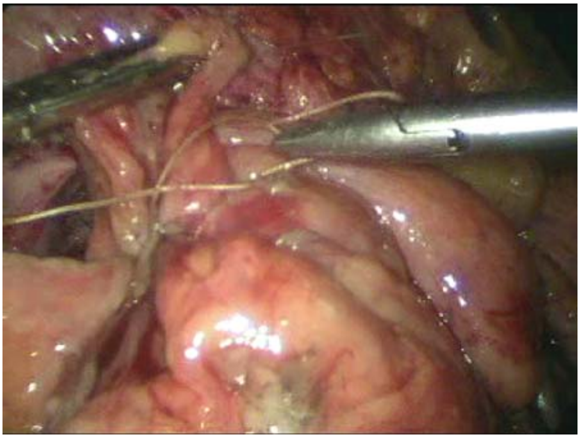

Fig. 15.2 Laparoscopic Graham patch completed

local drain is debatable and a matter of surgeon's preference. Thorough irrigation of the peritoneal cavity is essential to minimize the chances for an intraabdominal abscess postoperatively. Some surgeons would advocate concurrent vagotomy in these cases. Truncal vagotomy may be contraindicated without the addition of a gastric emptying procedure such as a pyloroplasty. A selective vagotomy may be too time-consuming in a patient undergoing an emergent operation for peritonitis. With our current understanding of the pathophysiology and etiology of most peptic ulcers and the availability of proton pump inhibitor medications, vagotomy at the time of Graham patch for perforation is usually not necessary.

15.1.1.2 Bleeding Peptic Ulcer

Most patients with bleeding from duodenal ulceration present with hematemesis with or without melena. Signs of hypovolemic shock are present in about 20% of patients at the time of presentation. Resuscitation begins during the initial evaluation. A large-bore nasogastric tube should be inserted to evacuate blood. Gastric lavage with warm saline can help prepare for endoscopic examination. Upper endoscopy is the preferred method of diagnostic evaluation. The majority of bleeding ulcers can be controlled endoscopically. When endoscopic therapy fails to control bleeding or in cases of massive exsanguination (especially when it is clear that the bleeding source is from a known peptic ulcer), surgical treatment is necessary. The bleeding peptic ulcer requiring surgery is typically approached via an upper midline laparotomy. A Kocher maneuver is performed to mobilize the duodenum. The duodenum and pylorus are opened longitudinally and parallel to the axis of the bowel on the anterior wall. The bleeding ulcer is sutured directly in the superior and inferior aspects of the base of the ulcer. Many duodenal ulcers in the posterior first portion of the duodenum erode into the gastroduodenal artery. This artery can bleed from both the proximal and distal end of the erosion

necessitating this 2-stitch approach to control the hemorrhage. Ligation of the gastroduodenal artery superior to the duodenum extraluminally is often ineffective due to a rich collateral network of arteries. One must be careful not to place a suture so deeply into the ulcer bed that the distal common bile duct is compromised. Intraoperative cholangiography can be valuable in ruling out this possibility in cases where there is a concern that this has occurred. The duodenum, pylorus, and prepyloric stomach can be closed via pyloroplasty. Of the three well-described types of pyloroplasty, a Heineke-Mikulicz pyloroplasty is the easiest to perform except in cases with extensive duodenal scarring. The operative technique for a Heineke-Mikulicz pyloroplasty is described in the next section. A truncal vagotomy can be quickly performed in most patients upon completion of duodenal closure.

15.1.1.3 Chronic Gastric Outlet Obstruction Due to Peptic Ulcer

Chronic gastric outlet obstruction is the least frequent complication of peptic ulcer disease seen today. Pyloric obstruction is the result of recurrent ulceration of the pyloric channel. Operative treatment of gastric outlet obstruction begins with inspection of the pyloroduodenal region at the time of laparotomy. In cases of focal scarring of the proximal duodenum and pylorus, a Heineke-Mikulicz pyloroplasty is the best option. A longer segment of duodenal scarring may necessitate a Finney pyloroplasty or a Jaboulay gastroduodenostomy. Occasionally, in the setting of a chronic gastric ulcer that fails to heal, a resection is the better option (antrectomy) for dealing with a gastric outlet obstruction or the recurrent ulcer itself.

Pyloroplasty

For a *Heineke-Mikulicz Pyloroplasty*, the first operative step is to adequately Kocherize the duodenum. The peritoneum lateral to the duodenum is divided. The majority of the duodenal mobilization can be done bluntly except in cases with severe local scarring due to inflammation from the ulcer. Once the duodenum is mobilized, an approximately 5-cm incision is made in the anterior wall of the distal antrum, across the pyloric sphincter and into the proximal duodenum. The opening should be centered as closely as possible on the pylorus itself. The opening should be long enough to divide the anterior wall of the entire scarred portion of the duodenum. The pyloroplasty can be performed in a hand-sewn single- or double-layered technique or using a stapler. For a sutured pyloroplasty, begin by determining the superior and inferior apices of the closure. These points are typically at the midpoint of the open bowel on the inferior and superior cut edge. With appropriate retraction on these corner stay sutures, the bowel can be closed in a direction perpendicular to the original longitudinal axis. In a 2-layers closure, be certain that the outer seromuscular layer does not result in significant narrowing of the lumen (Fig. 15.3). A Heinek e-Mikulicz pyloroplasty can be performed for indications other than gastric outlet obstruction. Truncal vagotomy and pyloroplasty is a well-described surgical therapy for recalcitrant peptic ulcer disease, particularly for duodenal ulcers. In the current era, this particular procedure for uncomplicated but chronic peptic ulcer

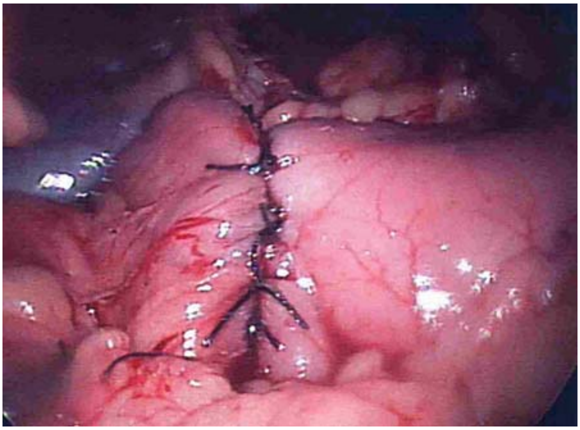

Fig. 15.3 Heineke-Mikulicz pyloroplasty

disease is rarely necessary. Heineke-Mikulicz pyloroplasty is sometimes performed for gastroparesis, often in conjunction with an antireflux procedure. The indications for adding a pyloroplasty to a fundoplication in patients with concomitant gastroesophageal reflux disease (GERD) and gastroparesis are debatable. If necessary, the pyloroplasty can be conducted laparoscopically at the time of a laparoscopic fundoplication. Additional ports are often necessary to get the operative field centered in the visual field and to ensure good triangulation with the working ports on the area of the pylorus. At the University of Wisconsin, we very selectively (rarely) perform a concurrent pyloroplasty at the time of fundoplication is cases with documented GERD and profoundly delayed and symptomatic gastric emptying.

A *Finney pyloroplasty* is sometimes necessary in cases with a longer or slightly more distal segment of duodenal scarring. This is basically a longer opening of the bowel closed in a side-to side manner, almost like a stricturoplasty for Crohn's disease. Extensive mobilization of the duodenum with opening of the duodenum through the entire area of the stricture/stenosis is necessary. A corner stay suture is placed in the apex, top corner of the anastomosis. From this point, a side-to-side anastomosis is constructed in a single or double layer. Care must be taken to ensure that the ampulla of Vater is not narrowed by the suture line. If it is not obvious where the ampulla is located, a thin silastic catheter threaded through the cystic duct and into the distal common bile duct may be useful for determining the anatomy. In a *Jaboulay Gastroduodenostomy*, the area of narrowing is essentially bypassed with a gastroduodenal anastomosis. A Jaboulay is ideal when the segment of duodenal scarring is long and extensive, especially when the second portion of the duodenum is clearly involved.

Resection and Vagotomy for Recalcitrant Peptic Ulcer Disease

When gastric ulcers fail to heal completely with standard medical management (avoidance of risk factors, proton pump inhibitors, *H. pylori* eradication), the possibility of malignancy must be reassessed. Other causes of non-healing include

Crohn's disease, gastric lymphoma, tuberculosis, and gastrinoma. Although the presence of gastric acid is necessary for gastric ulcers to develop, mucosal defects are more important in pathogenesis. As a result, gastric ulcer procedures that remove susceptible mucosa are most successful. The specific operation depends on the location of the ulcer and the extent of scarring. For most recalcitrant ulcers, antrectomy to include the ulcer and truncal vagotomy is the appropriate therapy.

Antrectomy for Peptic Ulcer

Through an upper midline incision, adequate exposure is attained. The avascular portion of the gastrohepatic ligament is incised and the left hand is passed behind the lesser curvature and antrum of the stomach, emerging deep to the gastroepiploic arcade along the greater curvature of the stomach. The branches going from the gastroepiploic arcade to the greater curvature should be isolated and divided along the greater curve from the halfway point between the pylorus and the diaphragm distally towards the pylorus. The distal segment of the gastroepiploic arcade is then carefully dissected away from the antrum, dividing the avascular attachments between the back wall of the antrum and the pancreas in order to free up the distal half of the greater curvature. This dissection should be performed carefully as there are many fragile veins in this vicinity, which may tear. Next , choose a point on the lesser curve near the angularis (Fig. 15.4) or proximal to the ulcer and scarring to serve as the proximal margin of the antral resection. Clamp the vascular bundle along the lesser curve and ligate and transect the left gastric artery, leaving a good-sized stump of vessel beyond each tie. Divide the stomach proximally with a linear stapler, using staples appropriate for the thick antral tissue of the stomach. Reflect the specimen anteriorly to expose the posterior wall of the duodenum and the anterior surface of the pancreas. Divide the small vessels in this plane and free about 2 cm of the posterior duodenal wall from the underlying pancreas. A linear cutting surgical

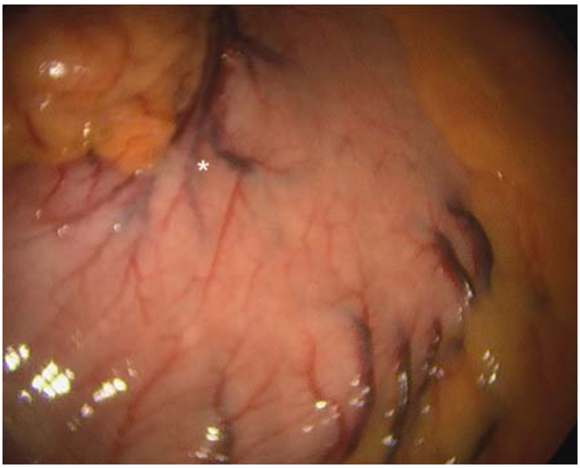

Fig. 15.4 Laparoscopic view of angularis (∗) of lesser curve of stomach

stapler may then be fired across the proximal duodenum. For duodenal ulcers, take great care when extending the duodenal resection margin distally as the ampulla of Vater may be compromised. Once the specimen is resected, it is good practice to send the tissue to pathology to confirm the presence of Brunner's glands in the distal margin. Brunner's glands are only present in the duodenum and not the stomach, so their presence in the specimen excludes the possibility of retained antrum syndrome, if the reconstruction method is via a gastrojejunal anastomosis (Billroth II or Roux-en-Y).

The preferred reconstruction method following antrectomy is via a gastroduodenostomy (*Billroth I*) when possible. This anastomosis is more physiologically sound and avoids several of the pitfalls associated with gastrojejunal reconstruction (retained antrum, duodenal stump leak, afferent limb syndrome). Enough healthy, non-scarred duodenum proximal to the ampulla must be present. The gastric remnant must reach the duodenal stump easily and without tension. To facilitate this, extensive duodenal mobilization (Kocher maneuver) and gastric remnant mobilization should be performed. The gastric remnant can be mobilized several centimeters by dividing the phrenoesophageal membrane and mobilizing the distal esophagus. This dissection at the diaphragm hiatus is usually necessary to perform a truncal vagotomy, which is typically added to a gastric resection for recalcitrant ulcer disease. If the gastric remnant and duodenum can be easily aligned without tension, a Billroth I anastomosis can be constructed using a single- or double-layered handsewn technique or with a stapled technique. All of the above can be conducted laparoscopically in the hands of experienced surgeons paying attention to the same principles. Figure 15.5 depicts a side-to-side stapled gastroduodenostomy after a laparoscopic antrectomy

In cases where the extent of antral resection or the degree of scarring precludes a Billroth I reconstruction, a *Billroth II* reconstruction is an attractive option. A Billroth II is essentially a loop gastrojejunostomy. Variations include the location of this anastomosis relative to the colon (antecolic or retrocolic) and relative to the

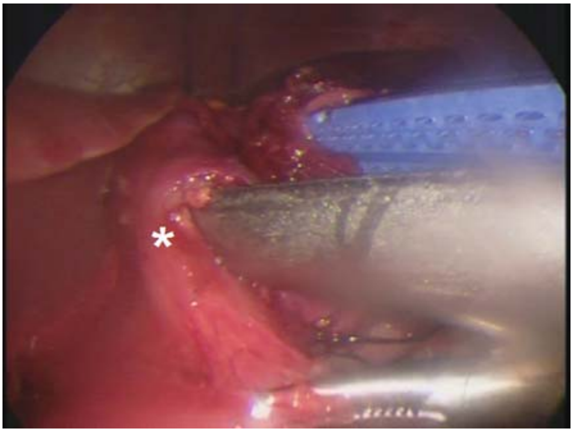

Fig. 15.5 Laparoscopic side-to-side stapled Billroth I anastomosis ($*$ = duodenal stump)

gastric remnant (antegastric or retrogastric). There are arguments for and against each of these options. The author prefers a retrocolic, retrogastric Billroth II anastomosis. The distance to the gastric remnant is shortest with the retrocolic approach and the posterior anastomosis may facilitate drainage. There is evidence to suggest that the biliopancreatic secretions in the afferent jejunal limb following a Billroth II first empty into the gastric remnant and then into the efferent limb rather than bypassing the gastric remnant entirely. A proximal portion of healthy jejunum that reaches easily to the gastric remnant is selected for the anastomosis. This is typically approximately 20 cm distal to the ligament of Treitz. Often a window in the transverse mesocolon to the left of the middle colic vessels is best. If the gastric remnant is mobile, the gastrojejunal anastomosis should lie entirely caudal to the mesocolon if possible. This will minimize the chances of the mesocolon kinking either the afferent or efferent jejunal limb. In such patients, the mesocolon should be sutured to the gastric remnant to close the defect. If this is not possible, the mesocolon defect should be closed taking great care not to impinge the lumen of the jejunum. A side-to-side hand-sewn or stapled anastomosis can be constructed. Special attention must be paid to the duodenal stump following antrectomy and Billroth II reconstruction. Local healthy omentum secured to the duodenal stump may help minimize the chances of duodenal stump blowout, a potentially deadly complication following Billroth II. A closed system soft drain near the stump may allow a small-contained leak to be managed non-operatively in select cases.

Vagotomy

In contemporary surgical practice, *bilateral truncal vagotomy* is the most common type of vagotomy performed. Truncal vagotomy is most often performed at the time of surgical treatment of bleeding peptic ulcer or in cases where recurrent peptic ulcers necessitate gastric resection. In truncal vagotomy, the esophageal hiatus is isolated and the esophagus is encircled. The anterior vagal trunk is often the more difficult of the two to isolate. Gentle caudal retraction on the stomach and superficial dissection through the periadventitial layer of the most superficial anterior longitudinal esophageal muscle fibers will reveal the fibrous band, that is the anterior vagus. The vagus should be isolated and a 1-cm segment excised between surgical clips. The posterior vagal trunk is a bit more obvious. This is a fibrous band, which can be snared with the index finger behind the distal esophagus in open vagotomy. In laparoscopic vagotomy, this nerve can be identified by gentle caudal retraction on the esophagus with a Penrose drain or another soft material encircling the esophagus (Fig. 15.6). Once a 1-cm segment of both nerves has been excised, these two pieces of tissue should be sent to pathology for a frozen section to confirm that each piece is indeed nerve tissue. Each segment should be specifically labeled anterior and posterior in the event that a particular nerve is missed with the first attempt. A *proximal gastric vagotomy* (also known as a *highly selective vagotomy* or a *parietal cell vagotomy*) involves the division of only the vagus nerves supplying the acid-producing portion of the stomach within the corpus and fundus. This procedure preserves the

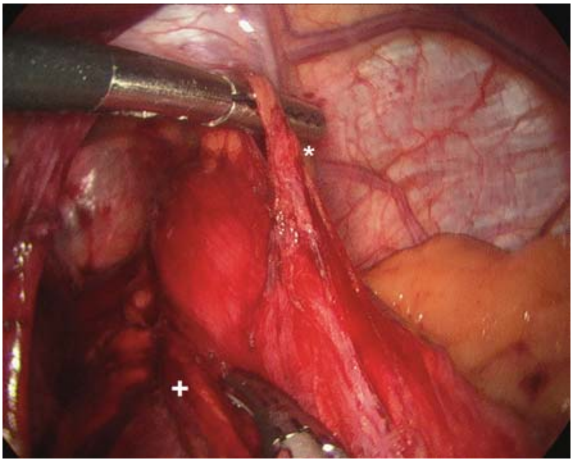

Fig. 15.6 Laparoscopic view of the anterior (∗) and posterior vagus trunks (+)

vagal innervation of the gastric antrum so that there is no need for routine drainage procedures. Consequently, the incidence of postoperative complications is less. In general, the nerves of Latarjet are identified anteriorly and posteriorly and the crow's feet innervating the fundus and body of the stomach are divided. These nerves are divided up until a point about 7 cm proximal to the pylorus or the area in the vicinity of the gastric antrum. Superiorly, division of these nerves is carried to a point at least 5 cm proximal to the gastroesophageal junction on the esophagus. Ideally, two or three branches to the antrum and pylorus should be preserved. The criminal nerve of Grassi represents a very proximal branch of the posterior trunk of the vagus, and great attention needs to be taken to avoid missing this branch in the division process because it is frequently cited as a predisposition for ulcer recurrence if left intact. While the proximal gastric vagotomy may be better tolerated than a truncal vagotomy, ulcer recurrence rates are higher.

15.2 Surgery for Gastric Neoplasms

15.2.1 Gastrointestinal Stromal Tumor (GIST)

15.2.1.1 Indications and Preoperative Evaluation

Gastrointestinal stromal tumors (GISTs) are rare neoplasms most often found in the stomach. Historically, these tumors were classified as leiomyomas, leiomyosarcomas, and leiomyoblastomas due to a mistaken belief that they originated from smooth muscle in the bowel wall. We now know that these tumors arise from cells in and around the myenteric plexus known as the interstitial cells of Cajal. The majority (approximately 95%) of GIST tumors express the CD117 antigen (KIT), a proto-oncogene product. Often, GISTs are asymptomatic and discovered incidentally during procedures such as endoscopy or CT scanning done for other

reasons. When discovered, evaluation includes endoscopy, endoscopic ultrasound, and CT scan of the abdomen to confirm the diagnosis and to evaluate for locally advanced or metastatic disease. When coupled with ultrasound-guided fine-needle aspiration (to evaluate for tumor markers) most submucosal gastric lesions can be determined to be GISTs with a high degree of certainty prior to surgical resection. Most gastric lesions that appear to be GISTs on evaluation should be resected surgically.

15.2.1.2 Resection of Local Disease (Gastric)

It has been demonstrated that the status of the microscopic margin of resection for gastric GISTs does not affect survival [2]. Lymph node metastasis is extremely rare for GISTs, and routine lymphadenectomy is not warranted. These factors have provided oncologic justification for minimally invasive resection techniques with gross margins for GISTs. Laparoscopic-stapled wedge gastric resections of greater and lesser curve lesions remote from the gastroesophageal junction and pylorus is relatively straightforward. During surgery, it is important to avoid manipulating the tumor, especially large lesions, due to the potential for tumor rupture. Intraoperative endoscopy is valuable for both localizing the lesion and for confirming the integrity of staple lines following resection. A linear cutting laparoscopic stapler with staple loads appropriate for thicker gastric tissue can be used to resect the wedge of gastric tissue including the tumor (Fig. 15.7). For anterior lesions, seromuscular sutures proximal and distal to the lesion can help to elevate the anterior gastric wall for resection with an endoscopic linear stapler. Larger lesions can be resected with an energy source such as an ultrasonic dissector or electrocautery. The gastrotomy may then be closed with either a stapler or with sutures. Posterior lesions can be a bit more difficult to resect. Techniques for posterior lesions include full mobilization

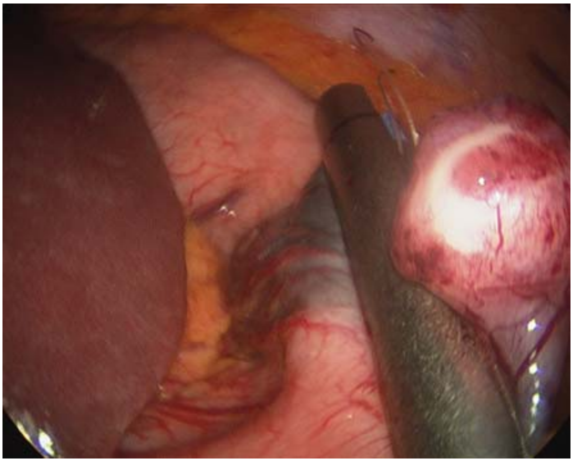

Fig. 15.7 Laparoscopic wedge resection of gastric GIST

of the greater curve, elevation, and cephalad rotation to expose the posterior stomach and then resection using techniques similar to those described previously for anterior lesions. An alternative technique involves the creation of an anterior gastrotomy over the endoscopically localized lesion. Sutures placed in the posterior gastric lumen proximal and distal to the lesion can be used to elevate the tumor through the gastrotomy, facilitating full-thickness resection with an intraluminal staple line. The anterior gastrotomy can then be closed with sutures or staples. Oversewing of the staple lines following resection is a matter of surgeon's preference. Endoscopy can help to determine that the resection is complete and that the resection does not compromise the lumen of the stomach.

15.2.2 Gastric Adenocarcinoma

15.2.2.1 Indications and Preoperative Evaluation

When evaluating a patient to determine resectability of gastric cancer, the National Comprehensive Cancer Network recommends chest radiography (or chest computed tomography for proximal tumors) and computed tomography of the abdomen and pelvis to assess for metastatic disease. Patients with local–regional disease should also have an upper endoscopy to obtain tissue for pathologic diagnosis and to assess the proximal and distal extent of the tumor. Endoscopic ultrasonography should also be done to assess depth of invasion (overall staging accuracy of EUS is about 75%) [3]. Staging laparoscopy with peritoneal washings should be done as a preoperative procedure or immediately prior to any planned resection. Positive peritoneal cytology is felt to be of the same prognostic significance as grossly metastatic disease and is a contraindication to resection. Tumors, which invade the aorta, celiac axis, or vena cava, are unresectable. Tumors that invade the left lobe of liver, the middle colic artery, or the body of the pancreas can still be resected in most reasonable-risk patients.

The lymphatic drainage of the stomach is extensive and gastric tumor extending through the submucosa is sometimes not apparent on gross examination. Early metastasis of tumor to regional nodes is common. Due to this fact, wide (6 cm) margins and extensive lymphadenectomy are recommended during surgery. The debate over the optimal extent of lymphadenectomy is still ongoing and is beyond the scope of this chapter. A D1 lymphadenectomy involves removal of all nodal tissue within 3 cm of the primary tumor. A D2 resection is D1 plus clearance of hepatic, splenic, celiac, and left gastric lymph nodes. A D3 lymphadenectomy is consistently endorsed by Japanese surgeons (gastric cancer is much more common in Japan than it is in the United States) and consists of a D2 lymphadenectomy plus omentectomy, splenectomy, distal pancreatectomy, and clearance of the porta hepatis and paraaortic lymph nodes. Subtotal gastrectomy is indicated for cancers of the body or antrum and total gastrectomy is indicated for malignancy of the cardia or fundus.

15.2.2.2 Subtotal Gastrectomy

These operations can be performed laparoscopically or via laparotomy for early gastric cancer (gastric cancer confined to mucosa or submucosal regardless of lymph node status) [4]. During open subtotal gastrectomy for gastric cancer, a careful inspection for metastatic disease is undertaken. If no metastatic disease is identified, the first step is to divide the avascular plane between the gastrocolic omentum and the transverse colon, separating the omentum from the transverse mesocolon. The pancreas, duodenum, and the origin of right gastroepiploic vessels are exposed. The right gastroepiploic artery is divided at its origin and all adjacent lymph nodes are swept towards the specimen. The left gastric is identified as it travels toward lesser curve and this vessel is followed back to its origin at the celiac axis. The left gastric artery is skeletonized and divided, sweeping associated lymphatic tissue toward the specimen. The coronary vein is just caudal to the artery and should also be ligated and divided as well. At the completion of this dissection, the anterior surface of the celiac axis and the aorta should be freed of lymphatic tissue.

The next step is to open the peritoneum over the common hepatic artery as it leaves the celiac axis and to follow this to the origin of the gastroduodenal artery. Dissect the hepatic artery and sweep the adjacent lymphatic tissue towards the specimen. Divide the right gastric artery. Kocherize the duodenum and dissect it from the anterior surface of the pancreas for 4–6 cm. Excise any visible lymphatic tissue along the superior margin of the pancreas, the splenic artery, and the paraduodenal region. The duodenum is then divided with a surgical stapler. Examine the extent of the tumor and divide the stomach at least 8–10 cm proximal to the tumor. Restoration of gastrointestinal continuity can be achieved with either a Billroth II gastrojejunostomy or a Roux-en-Y gastrojejunostomy, using the techniques described earlier in this chapter.

15.2.2.3 Total Gastrectomy

The dissection for a total gastrectomy is similar to that for a subtotal, only more proximal. As described above for subtotal gastrectomy, perform a complete omentectomy and identify and ligate the right gastroepiploic vessel at its origin. Divide the left gastric artery and coronary vein, as described above. Mobilize and divide the duodenum. A splenectomy should be performed if the splenic hilum or spleen is invaded by tumor. Next, divide the triangular ligament and retract the left lobe of the liver to the patient's right and incise the peritoneum overlying the abdominal esophagus. Bluntly dissect the esophagus away from the right and left crus, then encircle it with a Penrose or other soft drain and perform a bilateral truncal vagotomy. Incise the peritoneum over the right crus and identify the cephalad edge of the gastrohepatic ligament, which may contain an accessory left hepatic branch of the left gastric. Divide this vessel if present and then divide the gastrohepatic ligament. Examine the area behind the esophagocardiac junction and identify and divide any remaining esophagophrenic attachments, freeing up the posterior wall of

the stomach. Occlude the esophagogastric junction with umbilical tape or a linear staple line. Elevate the transverse mesocolon and identify the ligament of Treitz. Divide the jejunum approximately 15 cm distal to the ligament of Treitz with a linear cutting stapler. Make a 3 cm incision in the avascular portion of the transverse mesocolon to the left of the middle colic artery and pass the stapled end of jejunum through the incision and up to the esophagus. Be sure to suture the defect in the mesocolon to the wall of the jejunum to prevent herniation through the mesenteric defect.

An end-to-side sutured esophagojejunostomy, circular stapled esophagojejunostomy, or an end-to-side stapled esophagojejunostomy can be performed to restore intestinal continuity. Plan to divide the esophagus 6–10 cm above the proximal margin of visible tumor. If performing this procedure via an abdominal approach, it is helpful to take certain measures to ensure that the esophagus proximal to the resection does not retract into the mediastinum after division. The following sequence of steps ensures that this will not happen before you get the anastomosis setup to complete. Begin by inserting several interrupted sutures between the undersurface of the diaphragm and the posterior wall of the jejunum to prevent tension on the esophagojejunal anastomosis. Mark the proposed site of the opening in the jejunum along the antimesenteric border with cautery. Place one corner suture at the left and right ends of the proposed anastomosis and tag each preplaced suture with hemostat. Place several additional posterior row seromuscular interrupted sutures in between these two corner stitches. Prior to tying these sutures, divide the posterior wall of esophagus transversely until the mucosa has been divided. Next tie each pre-placed suture, leaving the corner sutures tagged after tying. Open the jejunum with electrocautery. Approximate the posterior mucosal layers with interrupted 4-0 absorbable sutures with the knots tied in the lumen. Next, pass a nasogastric tube through the partially complete anastomosis and into the jejunum under direct guidance. Divide the remaining esophagus, keeping the anterior wall slightly longer than the posterior wall. At this point, hand off the gastric specimen and send frozen sections to make sure that the proximal and distal margins are negative for residual tumor. Complete the anastomosis by approximating and inverting the anterior mucosal layer with interrupted absorbable sutures with the knots tied in the lumen followed by a layer of Lembert sutures. To restore intestinal continuity, perform an end-to-side Roux-en-Y jejunojejunostomy. Keep this anastomosis approximately 60 cm from the gastrojejunal junction to minimize bile reflux.

15.3 Complications and Postgastrectomy Syndromes

A variety of complications can occur following gastric resection. Duodenal stump leak is a particularly disastrous complication. In addition to the postgastrectomy syndromes described below, patients are also prone to recurrent or marginal ulcers. A marginal ulcer is most commonly located on the jejunal side of the anastomosis.

15.3.1 Dumping Syndrome

Dumping syndrome is categorized as either early or late. The early form of dumping syndrome usually occurs within 20–30 min after ingestion of a meal and is accompanied by both gastrointestinal and cardiovascular symptoms. Nausea and vomiting, cramping abdominal pain, and often explosive diarrhea are the most common gastrointestinal side effects. Additional symptoms may include palpitations, tachycardia, diaphoresis, fainting, dizziness, flushing, and occasionally blurred vision. This symptom complex can develop after any operation on the stomach but is more common after partial gastrectomy with the Billroth II reconstruction than it is following a Billroth I. It is thought that the mechanism behind early dumping is rapid passage of food of high osmolarity from the stomach into the small intestine. This occurs because gastrectomy or interruption of the pyloric sphincter prevents the stomach from preparing its contents and delivering them to the proximal bowel in the form of small particles in isotonic solution. The resultant hypertonic food bolus passes into the small intestine, which induces a rapid shift of extracellular fluid into the intestinal lumen to achieve isotonicity. After this shift of extracellular fluid, luminal distention occurs and induces the autonomic responses listed previously.

Many patients following gastric surgery complain of some dumping symptoms after surgery. Most experience spontaneous relief and require no specific therapy. For others, dietary measures including avoiding foods containing large amounts of sugar, frequent feeding of small meals, and separating liquids from solids during a meal usually suffice.

Late dumping symptoms occur approximately 2–3 h after a meal. Late dumping is less common than early dumping. In late dumping, carbohydrates that are delivered to the small intestine are quickly absorbed resulting in hyperglycemia. This triggers the release of large amounts of insulin to control the rising blood sugar resulting in overshooting that actually leads to hypoglycemia in response to the insulin. The hypoglycemia results in the release of catecholamines with resultant diaphoresis, tremulousness, lightheadedness, tachycardia, and confusion. The symptom complex is indistinguishable from insulin shock. Late dumping patients should be advised to ingest frequent small meals and to reduce their carbohydrate intake. Some patients have found benefit with pectin, either alone or in combination with acarbose, an α-glucoside hydrolase inhibitor that delays carbohydrate absorption through impairment of intraluminal starch and sucrose digestion.

15.3.2 Alkaline Reflux Gastritis

Following gastrectomy, reflux of bile is fairly common. In some patients, this reflux is associated with severe epigastric pain accompanied by bilious vomiting and weight loss. This syndrome most frequently occurs after a Billroth II reconstruction. Gastritis is due to reflux of biliopancreatic content into stomach, leading to gastric mucosal injury [5]. Although the diagnosis can be made by taking a careful history, HIDA scans are usually diagnostic, demonstrating biliary secretion into

the stomach and even into the esophagus in severe cases. Unfortunately, most of the medical therapies that have been tried to treat alkaline reflux gastritis have not shown any consistent benefit. For those patients with intractable symptoms, surgery is recommended. The surgical procedure of choice usually involves converting the Billroth II anastomosis into a Roux-en-Y gastrojejunostomy in which the Roux limb has been lengthened to 40–60 cm [6].

15.3.3 Afferent Loop Syndrome

Afferent loop syndrome occurs as a result of partial obstruction of the afferent limb that is unable to empty its contents. Afferent loop syndrome can occur from a variety of causes. It can arise secondary to kinking and angulation of the afferent limb, internal herniation behind the efferent limb, stenosis of the gastrojejunal anastomosis, a redundant twisting of the afferent limb with a resultant volvulus, or adhesions involving the afferent limb. The syndrome usually occurs when the afferent limb is too long (greater than 30–40 cm in length). Antecolic loop gastrojejunostomies are also more likely to lead to the afferent loop syndrome than the retrocolic variant. Biliopancreatic secretions accumulate in the obstructed afferent limb. Distention leads to abdominal pain and eventually leads to forceful bilious vomiting as the afferent loop decompresses into the gastric remnant. Usually, ingested food has emptied into the efferent limb so that the vomitus is bilious without food. In the setting of complete obstruction, necrosis and perforation of the loop can occur, as the obstruction is a closed loop because the duodenum proximally has already been closed during the Billroth II gastrectomy. In this situation, constant abdominal pain is experienced. This is a surgical emergency and requires immediate attention. In most patients with afferent loop syndrome, the obstruction is only partial.

Diagnosis of chronic afferent loop syndrome can be difficult. Plain films may demonstrate a distended, fluid-filled loop of bowel in the right upper quadrant. A CT scan may demonstrate the same. Upper GI series and upper endoscopy can provide additional information helpful in confirming the diagnosis. Operation is usually indicated when the diagnosis is made. A long afferent limb is often the underlying problem and treatment may involve the shortening of this loop. An enteroenterostomy (Braun type) below the anastomosis can relieve the symptoms from an afferent loop obstruction. Conversion of a loop to a Roux-en-Y gastrojejunostomy can also resolve this condition.

15.3.4 Efferent Limb Syndrome

Obstruction of the efferent limb is a fairly rare occurrence. Initial complaints include crampy left upper quadrant and epigastric pain associated with bilious emesis. The syndrome is due to partial or complete mechanical obstruction of the efferent limb at or near the gastrojejunostomy and is most commonly produced by internal herniation of the efferent limb behind the anastomosis, although it can also be secondary

to anastomotic stricture or stenosis. Diagnosis is with upper GI series, CT scan, or upper endoscopy. Operative intervention is almost always necessary and consists of reducing the retro-anastomotic hernia and closing the retro-anastomotic space to prevent recurrence of this condition.

15.3.5 Retained Antrum

Antral mucosa may extend past the pyloric muscle for up to 0.5 cm. For this reason, the syndrome of retained gastric antrum may occur after partial gastrectomy even if the resection is carried beyond the pyloric sphincter. A Billroth II anastomosis can therefore result in the development of a retained antrum syndrome. In this situation, the retained antrum is continually bathed in alkaline secretions from the duodenum, pancreas, and liver that stimulate the release of large amounts of gastrin. High gastric levels stimulate the secretion of acid. Many recurrent ulcers after antrectomy and Billroth II reconstruction are related to this condition. The majority of patients with retained antrum following Billroth II gastrectomy will develop a recurrent ulcer.

Diagnosis can be made with the aid of a technetium that demonstrates a hot spot adjacent to the area where normal uptake of technetium by the gastric mucosa of the remaining stomach occurs. Review of previous operative reports and pathology reports (looking for Brunner's glands) may help to rule out this condition, when a variety of possible causes for recurrent ulceration exist. If a retained antrum is diagnosed, proton pump inhibitors may prove helpful in controlling acid secretion. If this is ineffective, either conversion of the Billroth II to a Billroth I reconstruction or excision of the retained antral tissue in the duodenal stump is indicated.

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Part IV
Small Bowel and Appendix Surgery

Section Editor: Peter F. Nichol

Chapter 16
Small Bowel Resection

Pablo Laje and Peter F. Nichol

16.1 Indications

Small bowel resections are very common in the adult and pediatric general surgery practice. The reasons for performing a small bowel resection are numerous and include bowel obstruction, vascular compromise, hemorrhage, neoplasms, inflammatory disease, fistulas, and congenital anomalies. In spite of the myriad of potential indications, the approach is generally the same for each situation.

16.2 Preoperative Preparation

When small bowel resection is indicated, the patient is preferably made NPO 6 h prior to surgery. In more urgent/emergent cases a nasogastric tube is placed preoperatively to decompress the stomach. A single dose of antibiotics (usually a second generation cephalosporin) is administered 1 hour prior to the beginning of the operation.

16.3 Positioning and Anesthesia

All patients undergo a general anesthetic with endotracheal intubation. In cases where the patient is obstructed, a rapid sequence induction is performed by anesthesia in combination with gentle pressure exerted on the trachea by an assistant in order to compress the esophagus and prevent reflux of gastric contents (Sellick's maneuver). Intravenous paralytics are frequently used during the open and laparoscopic approaches to maximize abdominal wall relaxation and facilitate the resection. In elective cases where a midline incision will be required, an epidural catheter can be placed preoperatively to optimize post-operative pain control.

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All procedures are preformed with the patient in the supine position. In adults, sequential compression devices are placed on the legs prior to the induction of anesthesia to prevent formation of deep vein thromboses. A urinary catheter is placed to monitor urine output and in the case of the laparoscopic approach prevent injury to the bladder during trocar placement. For the open approach, most patients are traditionally positioned with the arms extended laterally on arm boards at a 90° angle from the body's axis. For the laparoscopic approach it is preferable to have one or both arms tucked at the patient's side as dissection in the pelvis requires the surgeon to stand near the patient's chest. In the obstructed patient it is critical to have a nasogastric tube in place throughout the procedure to assist in the retrograde decompression of the intestine proximal to the obstruction.

16.4 Description of the Procedure

Open resection: The open approach is the best approach when dealing with patients who are either (1) massively distended from an obstruction, (2) have significant adhesions from previous abdominal surgeries, (3) are hemodynamically unstable (sepsis or heart failure), (4) are undergoing radiation therapy to the abdomen [1], or (5) for other various reasons will not tolerate a pneumoperitoneum (pulmonary hypertension). In children under the age of 2, a centrally placed transverse incision is made 1–2 fingerbreadths above the umbilicus. This permits access to the entire peritoneal cavity. After the age of 2, a vertical midline incision is preferable. The location of the vertical midline incision can be adjusted inferiorly or superiorly based on the anticipated anatomical location of the surgical problem. Usually the surgeon starts out by making a small vertical midline incision around the umbilicus and extending it superiorly or inferiorly as required. In reference to the abdomen that is likely to have intense adhesions from previous surgeries, one critical maneuver is to extend the incision beyond the surgical scar and enter the peritoneal cavity at a point where there is unlikely to be adhesions. On rare occasions, the patient may have such dense adhesions from their underlying disease or from recent surgery that a full-length midline incision is inadequate to mobilize the intestine in a safe manner. In this situation I will make a lateral incision from center of the midline incision toward the side of the dense adhesions. I will extend this to the midaxillary line, if necessary. This technique is routinely employed during evisceration for multivisceral transplant and can greatly facilitate safe and efficient dissection of the intestine. Thereafter, the adhesions are taken down sharply and the intestine is freed up along its entire length. It is critical to run the entire bowel, identify the diseased segment, and confirm that the remainder of the intestine is normal.

After the diseased segment is identified, the bowel is divided between clamps (Fig. 16.1) or more commonly with a stapler. As a general rule, when the bowel is ready to be transected, it is recommended to isolate the operative field as much as possible by adding extra sterile drapes, to avoid the contamination of the abdominal cavity.

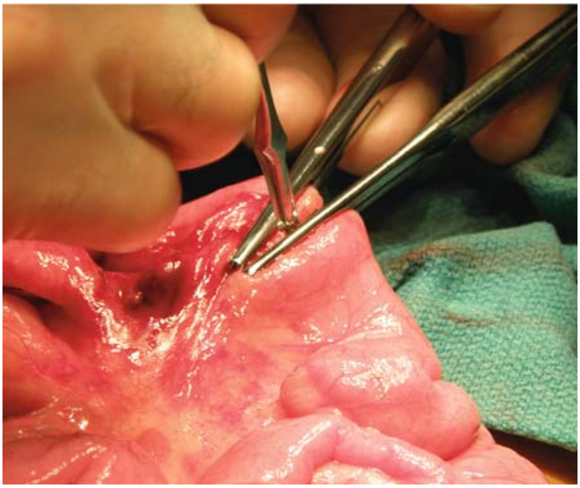

Fig. 16.1 The intestine is sharply divided between Allen-Kocher clamps

The affected segment is resected with its mesentery. This is of particular importance when dealing with neoplasms in order to get an adequate sampling of mesenteric lymph nodes. Identification and isolation of vascular arcades and their feeding vessels is facilitated by transillumination with the overhead lights. The arteries and veins are ligated with two ties and cut in between (Figs. 16.2 and 16.3). Occasionally the surgeon encounters a tremendously thickened mesentery with necrotic lymph nodes as a result of Crohn's disease or intestinal tuberculosis. In this situation, finger fracture of the necrotic nodes will thin the mesentery and enable identification and ligation of the vessels. Finally, in the situation where the patient is so critically ill that the surgeon has every intention of dropping the ends of the resection back into the abdomen and performing the anastomosis at a later

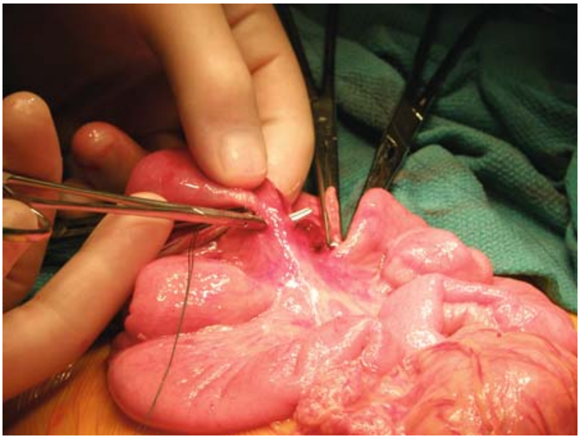

Fig. 16.2 The mesentery is taken between ties

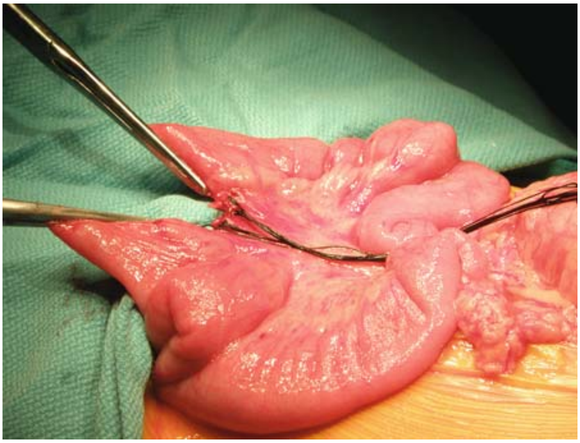

Fig. 16.3 The proximal and distal ends of intestine after resection of the diseased segment

time, the entire resection of the affected bowel and its mesentery can be performed in a matter of minutes with a surgical stapler using a vascular load to divide the mesentery.

The anastomosis of the bowel can be performed in a hand-sewn fashion or with a stapling device. A hand-sewn anastomosis is usually performed end-to-end in two layers. The inner layer is done in running fashion with full-thickness bites using monofilament absorbable suture (Figs. 16.4 and 16.5). It assures hemostasis and guards against anastomotic bleeding. The outer layer of the anastomosis consists of interrupted sutures placed in Lembert fashion (Fig. 16.6). The choice of suture depends in large part on the internal diameter of the intestine. For example, in infants, the inner layer is usually completed with a 5-0 monofilament suture and the outer layer is completed with 4-0 or 5-0 silk. In larger children and adults the inner layer is fashioned with 4-0 monofilament suture and the outer layer with 3-0 silk.

Fig. 16.4 The completed back wall of the inner layer of a two-layered anastomosis. This was done in simple running fashion with a 4-0 PDS suture. The outer layer of sutures (not visualized here) was fashioned with interrupted 3-0 silk sutures

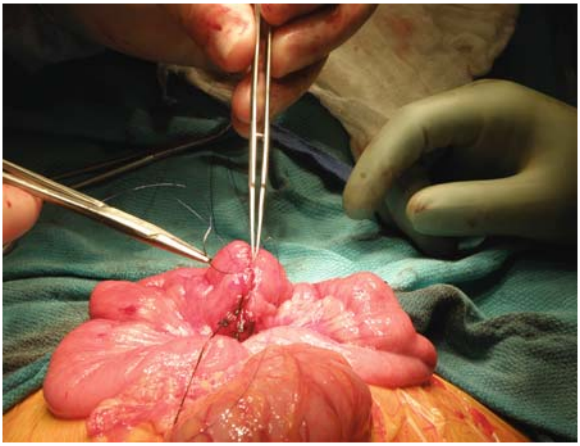

Fig. 16.5 Completion of the inner layer of the anastomosis with a running 4-0 PDS suture. The anterior wall is completed in running Connell fashion to ensure inversion of the mucosa

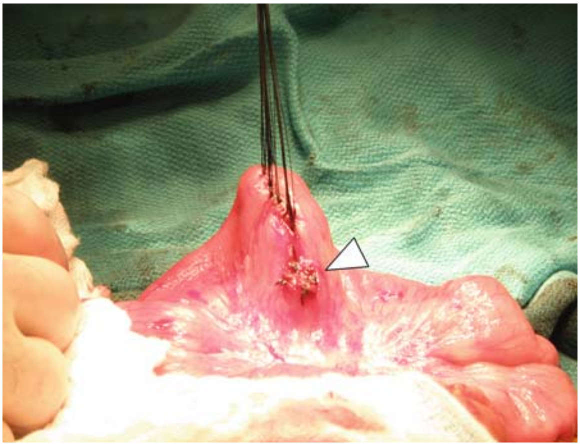

Fig. 16.6 The completed anastomosis. The outer layer was fashioned with 3-0 silk suture. The small mesenteric defect (*arrow head*) was closed with a 4-0 PDS suture in running fashion

Stapled anastomoses takes less time than hand-sewn anastomoses. They are usually performed in a side-to-side fashion but function end-to-end. Small enterotomies are made on the anti-mesenteric corner of the end or each segment of bowel. Each arm of the stapler is introduced into each limb of the intestine. The anti-mesenteric walls of the limbs are aligned and the stapler is fired creating a large enteroenterostomy. The anastomosis is completed by stapling across the now common enterotomy created by the first stapling maneuver. Before closing the common enterotomy, it is essential to make certain that hemostasis is assured along the first staple line. Bleeding vessels are oversewn with monofilament absorbable sutures and include the adjacent region of the staple line. On the serosal surface of the bowel, the point between the two limbs of bowel where the staple line ends and the limbs separate is usually re-enforced with several interrupted Lembert sutures.

In both the hand-sewn and stapled anastomoses, the mesentery is closed with a running absorbable monofilament suture with care taken not to injury the vessels of the mesentery. It is important to confirm the patency and the integrity of the anastomosis prior to closing the abdomen. In larger patients, the surgeon should be able to feel the aperture of the anastomosis through the intestinal wall with his or her index finger and thumb. The intestine is gently occluded proximally and distally and the succus and air within the bowel is placed under some gentle pressure and passed back and forth through the anastomosis. In infants, after occlusion proximally and distally, the intestinal lumen of the isolated segment is injected 2 cm proximal to the anastomosis with normal saline using a 3-0-gauge needle and syringe.

Laparoscopic approach: All the maneuvers required for an open small bowel resection can be safely and effectively performed using minimally invasive techniques. The division of the vascular supply can safely be achieved with the aid of sealing devices, bipolar cautery, monopolar cautery, metal clips, laparoscopic loops, or simple ties. The bowel can be transected and the anastomosis performed adequately with common laparoscopic instruments. Furthermore, in teenagers and adults (who are suitable for the placement of a 12- to 15-mm port) endoscopic staplers can be used to perform a side-to-side anastomosis.

We prefer a lap-assisted approach with an extracorporeal anastomosis. A minimum of three ports is required for a complete intraabdominal bowel resection and anastomosis; however, a fourth port is usually necessary to facilitate the procedure. The port size depends on the patient's size. In newborns and infants, procedure can be performed with 3-mm instruments. In larger children, a combination of 3- and 5-mm instruments is adequate, and in teenagers and adults a combination of 5- and 12-mm ports are required. The initial port is generally introduced through the umbilicus and the position of the remaining ones will depend on the segment of bowel to be resected. However, the surgeon wants to have the ports placed on the opposite side of the abdomen from where the affected segment is located. The working ports should be positioned in a triangular fashion around the camera port. Following identification and dissection of the affected bowel, it is subsequently exteriorized through a slightly enlarged umbilical incision for the completion of the resection, thus avoiding the contamination of the abdominal cavity. Once the intestine is delivered, it is divided on one end with the stapler, the mesentery is taken between ties until the other extent of the segment is reached and the resection is completed with another fire of the stapler. The anastomosis and closure of the mesenteric defect is completed in extracorporeal fashion. This combined approach is particularly useful in patients with a thin abdominal wall in which only a short segment of bowel needs to be resected (e.g., Meckel's diverticulum, a small intestinal duplication, etc.). This approach can be modified for sections of bowel that are enlarged or thickened. In this setting, delivery of the intestine through a small incision is problematic. The intestine is divided laparoscopically on one end with the stapler and the mesentery is taken down near the staple line with a thermal instrument. The staple line is then grasped with an instrument through the umbilical port.

The umbilical incision is then widened and the intestine is delivered through the wound. Resection then proceeds as described previously.

The two main disadvantages of a complete laparoscopic small bowel resection are: (1) the unavoidable contamination of the abdominal cavity when the bowel is transected and (2) the longer operative time of performing a hand-sewn laparoscopic anastomosis. As a result most surgeons favor the stapled intracorporeal anastomosis. The principles of this technique are the same as for the open stapled anastomosis. Additional disadvantages are that the surgeon has limited tactile feedback and intraluminal surveillance of the staple line for hemostasis is somewhat limited. The bowel is divided on either end with the stapler. The mesenteric vessels are taken with a thermal instrument. Large vessels are secured proximally with a laparoscopic loop after division. The resected segment is delivered through an enlarged periumbilical incision. The antimesenteric sides of each limb of bowel are aligned and the alignment is maintained with a series of stay sutures. Enterotomies are fashioned with an ultrasonic scalpel at the antimesenteric corners and the anastomosis is created with several fires of the laparoscopic stapler. The anastomosis is then completed with an additional fire of the laparoscopic stapler to seal the common enterotomy.

16.5 Postoperative Care

The length of postoperative stay is largely influenced by the underlying disease process that led to the resection. In patients with either sepsis or obstructive disease a nasogastric tube is left in place until the output is no longer green and the volume averages less than 100 mL per shift over 24 h. In elective resections, the patient does not require a nasogastric tube and oral intake can be started 8 h after surgery. Unless there has been gross contamination of the abdomen, antibiotics can be discontinued after 24 h. In patients who are not critically ill, the urinary catheter is removed shortly after surgery and ambulation is commenced on the evening of surgery. If no epidural catheter was used for the procedure, adequate pain control can be achieved with a combination of intravenous narcotics and non-steroidal anti-inflammatory medications, which can then be transitioned to oral medications once it is clear that the patient can tolerate oral intake. Generally the patient is discharged to home once they are tolerating a regular diet, ambulating, and their postoperative pain is adequately controlled with oral medications.

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Chapter 17
Meckel's Diverticulum Resection

Peter Mattei

17.1 Indications

Meckel's diverticulum is a congenital diverticulum of the small intestine that occurs in 2–3% of the population. It represents a remnant of the omphalomesenteric duct and its wall is comprised of all the layers that normally occur in the bowel, making it a true diverticulum. Ectopic tissue may be present, including gastric mucosa or pancreatic tissue. Most Meckel's diverticula remain clinically silent, with fewer than 25% becoming apparent, mostly in the first two decades of life [1].

The clinical presentation is highly variable: (1) gastrointestinal bleeding due to acid production by ectopic gastric mucosa and subsequent peptic ulceration; (2) intestinal perforation due to full-thickness peptic ulceration; (3) intussusception with the inverted diverticulum serving as a lead point; (4) volvulus around a congenital point of fixation of the diverticulum to the underside of the umbilicus; (5) bowel obstruction due to incarceration within an internal hernia created by a congenital adhesive band or separate blood supply from the mesentery to the tip of the diverticulum; (6) diverticulitis secondary to obstruction of the lumen by inspissated food residue, ingested foreign material, or neoplasm; (7) entrapment of the diverticulum within an abdominal hernia (Littre's hernia); (8) the origin of an omphalomesenteric (*vitelline*) duct remnant, and (9) an incidental finding during laparotomy or laparoscopy.

17.2 Preoperative Preparation: Imaging Studies

There is no specific imaging study that is sufficiently sensitive to confirm or exclude the presence of a Meckel's diverticulum with any degree of certainty. It is therefore

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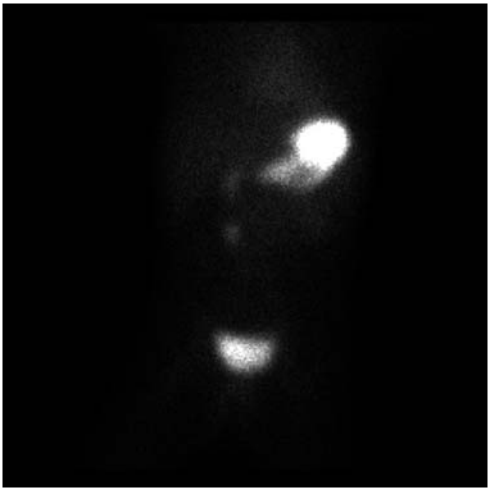

Fig. 17.1 ^{99}Technetium sulfur colloid nuclear medicine scan ("Meckel's scan"). The tracer is taken up by gastric mucosa, which is commonly found in Meckel's diverticula that have caused peptic ulceration and gastrointestinal bleeding. This scan shows the stomach in the left upper quadrant and radiotracer in the bladder. The subtle "spot" in the center of the abdomen represents the Meckel's diverticulum

unusual to be able to identify it as a cause of a particular disease process before the operative procedure.

Bleeding due to Meckel's diverticulum can be profuse but is usually painless and can be surprisingly difficult to confirm. Nuclear medicine studies that utilize ^{99}technetium sulfur colloid, which is taken up by gastric mucosa, are sometimes helpful (Fig. 17.1). The reported sensitivity of this test is approximately 85% [2] and is improved by pretreatment with pentagastrin or histamine-2 blockers, but in actual clinical practice our experience and that of others suggest that the sensitivity is closer to approximately 66% [3]. The patient with bleeding of unknown origin and a negative "Meckel's scan" might therefore still be a candidate for diagnostic laparoscopy to rule out the presence of a Meckel's diverticulum.

The Meckel's scan is only useful when gastric mucosa is present within the diverticulum and is therefore only used in the setting of GI bleeding. Likewise, although a Meckel's diverticulum might occasionally be identified by upper GI contrast studies, ultrasound, or CT scan, the diagnosis is nearly always based simply on a high index of suspicion or confirmed during an emergency procedure for an acute abdomen.

17.3 Surgical Approach

The operative approach can be laparoscopic, minilaparotomy, or full laparotomy and is determined by the clinical indications for surgical intervention. Laparoscopy can be useful to confirm the diagnosis or as an adjunct to minilaparotomy, and in most children the crucial elements of the operation (diverticulectomy or bowel resection) can usually be performed through a periumbilical incision. Rarely is a full laparotomy necessary.

17.4 Description of the Procedure

When the surgeon suspects the presence of a Meckel's diverticulum, standard laparoscopic techniques are generally adequate [4, 5]; however, to avoid injury to a Meckel's diverticulum that is adherent to the underside of the umbilicus, it is recommended that the initial port site incision be made away from the umbilicus rather than in the usual periumbilical location (Fig. 17.2). After placement of two more port sites, the abdomen can be inspected carefully to look for a diverticulum. The first place to look is the umbilicus, where an attachment may be found; this is easily lysed with electrocautery or harmonic scalpel. In the absence of an umbilical attachment, the small intestine needs to be inspected systematically. The typical location for a Meckel's diverticulum is in the distal ileum and so the bowel should be examined starting at the ileocecal valve.

Once the Meckel's diverticulum is identified, there are several treatment options. In most cases, the diverticulum can be simply excised at its base, being careful that the subsequent suture line is oriented transversely to avoid narrowing of the ileal lumen. We find that a gastrointestinal stapling device works best in these situations. Alternatively, the diverticulum can be excised using a V-shaped incision that is then repaired transversely using a single- or double-layered hand-sewn technique. Finally, the segment of ileum from which the diverticulum arises may be excised in the manner of a standard bowel resection with primary end-to-end hand-sewn or stapled anastomosis. This approach should be used in cases of bowel perforation or bleeding due to peptic ulceration as the ulcer is nearly always at the base of the diverticulum or in the ileum adjacent to the base. Ileostomy is rarely, if ever, indicated in patients with Meckel's diverticulum.

Simple diverticulectomy can be performed intracorporeally but it is usually preferable to simply exteriorize the diverticulum through a 10 mm periumbilical port incision and perform the excision or bowel resection and reanastomosis outside of the abdomen (Fig. 17.3). It can be argued that the entire operation could be

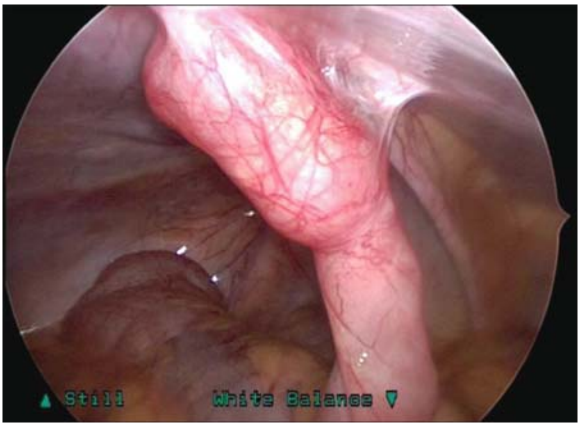

Fig. 17.2 Meckel's diverticulum adherent to the undersurface of the umbilicus in a patient who presented with intermittent volvulus. A standard peri-umbilical laparoscopic incision could have caused injury to the bowel. In this case, a lateral incision was made first in order to inspect the umbilicus

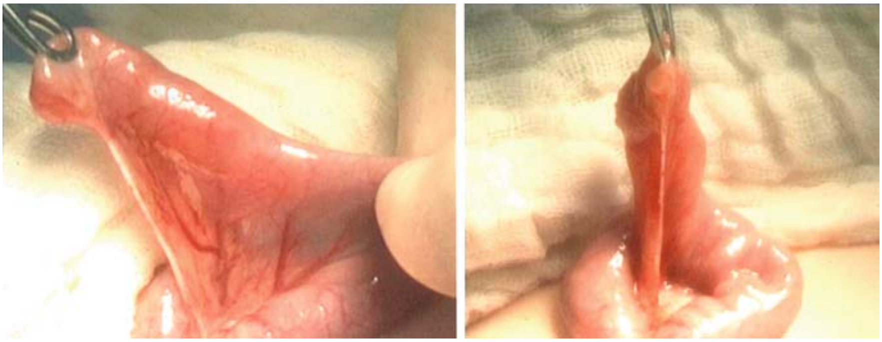

Fig. 17.3 Meckel's diverticulum delivered through a standard 10 mm peri-umbilical port-site incision. Note the independent mesentery

performed through a periumbilical or small right lower quadrant incision, which is probably true in most cases; however, given the variability of presentation, the possibility of attachment to the umbilicus and the customary diagnostic uncertainty, we find the use of a laparoscopic-assisted approach to be safe and effective in nearly all cases.

17.5 Postoperative Care

Most patients who have undergone Meckel's diverticulectomy can be treated using standard postoperative regimens. In fact, in the absence of obstruction or frank peritonitis, most can be treated using a modified fast-track protocol, including no routine nasogastric tube, early diet advance, and early ambulation. A typical postoperative length of hospital stay should be approximately 2–3 days.

Postoperative complications are uncommon and not specific to patients with Meckel's diverticulum. As with any abdominal procedure, there is a small risk of small bowel obstruction due to adhesions. Anastomotic complications such as leak and stricture should be exceedingly rare. After diverticulectomy, every child should be asymptomatic and participate in all activites without restriction.

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Chapter 18
Appendectomy

Ari Reichstein and Peter F. Nichol

The appendectomy is one of the most common emergent abdominal operations performed in the western world [1]. Despite this abundance of experience, fundamental questions about the pathogenesis, diagnosis, and management of appendicitis remain unanswered. Although a thorough exploration of these controversies is beyond the scope of this chapter, the list of suggested readings provides a starting point for exploring these issues.

18.1 Indications

The indications for appendectomy include the acute presentation of appendicitis, interval appendectomy for ruptured appendicitis, and a small mass (>1 cm) of the appendix or an appendicolith found incidentally on an imaging study.

Appendicitis classically presents with the triad of fever, anorexia, and characteristic abdominal pain that evolves from vague peri-umbilical discomfort (visceral pain) to focal right lower quadrant pain (somatic pain). This somatic pain is progressive and not intermittent. The progression from initial symptoms to focal right lower quadrant pain is usually 24 hours in duration. On physical exam, patients have right lower quadrant tenderness to palpation with rebound and guarding.

Although a wide range of diagnostic tests have been evaluated for their precision and accuracy in diagnosing appendicitis, none are a substitute for a careful history and examination. In a young, otherwise healthy patient with this disease, the classic history and findings on physical exam are frequently reason enough to proceed with appendectomy. In general, most patients will have a mild elevation in their white blood cell count and a shift in their neutrophils to greater than 70%. Imaging studies may be required when the presentation or symptoms are not "Classic" for appendicitis. CT scans are regarded as the imaging modality of choice, in part because of the ability to identify other

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causes of abdominal pathology that may present in a similar fashion. Both imaging and laboratory studies should be considered adjuncts to a thorough clinical assessment.

18.2 Choice of Surgical Approach

Over the last 20 years, laparoscopic appendectomy has gradually become the surgical procedure of choice for this disease, with open appendectomy reserved for patients presenting with obstruction, sepsis, or other contraindications to laparoscopy. However, the choice of the laparoscopic versus the open approach remains fundamentally one of surgeon preference. The conventional, open approach is generally regarded as faster and more cost effective in slender, otherwise healthy patients. In contrast, the laparoscopic approach is preferred for obese or muscular patients, in order to avoid larger incisions. Laparoscopy also has the advantage of being an excellent diagnostic modality for evaluating the myriad of disorders that can mimic appendicitis, including perforated peptic ulcer disease, Meckel's diverticulitis, inflammatory bowel disease, and tubal or ovarian pathology. The laparoscopic approach should thus be the procedure of choice for evaluating women of childbearing age or patients with atypical presentations. Absolute contraindications to the laparoscopic approach include immunosuppression and current radiation therapy [2]. Relative contraindications include intraperitoneal adhesions, coagulopathy, or known appendiceal abscess. Conflicting data exists comparing the safety of laparoscopic to open appendectomy in pregnant patients. Given the current lack of consensus on this issue, pregnancy should be considered a relative contraindication to laparoscopic appendectomy.

18.3 Preoperative Preparation

Once the decision to pursue operative intervention is made, no further diagnostic imaging is necessary. Although early appendiceal perforation is rare, the incidence rises dramatically the longer surgery is delayed, reaching approximately 80% at 48 h from the onset of symptoms. Since appendiceal perforation is the prime risk factor for developing post-operative complications, patients should be taken to the operating room in an expeditious manner. Very ill patients with delayed presentation or perforated appendicitis may need aggressive fluid resuscitation and electrolyte replacement prior to surgery. Patients with non-perforated, uncomplicated appendicitis can receive a single preoperative dose of prophylactic intravenous antibiotics. Adequate gram positive and enteric coverage can be achieved with a second-generation cephalosporin. Prior to induction of anesthesia, sequential compression devices (SCDs) are placed on the legs to reduce the risk of deep venous thrombosis.

18.4 Open Appendectomy

The patient is placed in the supine position and general anesthesia is induced. A 2–4 cm transverse or McBurney's skin crease incision is made over the point of maximal tenderness, and electrocautery is used to extend the dissection through the subcutaneous tissue. If the superficial inferior epigastric vein is encountered, it is ligated and divided with absorbable suture. The external oblique is exposed and its aponeurosis is incised parallel to its fibers. The external oblique fibers are bluntly separated with a hemostat and retracted to expose the internal oblique. The internal oblique is exposed and separated along the length of its fibers in a similar fashion. Next, the transversalis fascia and peritoneum are grasped with toothed forceps and elevated. Taking care not to injure the underlying bowel, both layers are incised sharply and extended to provide adequate exposure. At this point, the goal of dissection is to locate and deliver the appendix and base of the cecum into the surgical field. If the anterior tenia is immediately visible upon entering the abdomen, then the lower pole of the cecum can often be located by tracking the tenia distally to the convergence at the base of the appendix. Small bowel and/or omentum may obscure the cecum, and will need to be carefully displaced medially to allow proper exposure. Sometimes tenia coli exposed through this incision belong to a redundant sigmoid colon, which is consequently mistaken for cecum. If the cecum is difficult to maneuver, the lateral peritoneal attachments will have to be divided by identifying and incising along the white line of Toldt.

Once identified and mobilized, the cecum is grasped with a moist gauze and drawn into the incision with a gentle back-and-forth rocking motion. Using the convergence of the tenia coli as a landmark, the base of the appendix is located and exposed (Fig. 18.1). Next, the mesoappendix and appendiceal artery are taken between clamps and ligated with 3-0 silk or absorbable ties. The base of the appendix is crushed with a clamp and the proximal edge of the crushed segment is

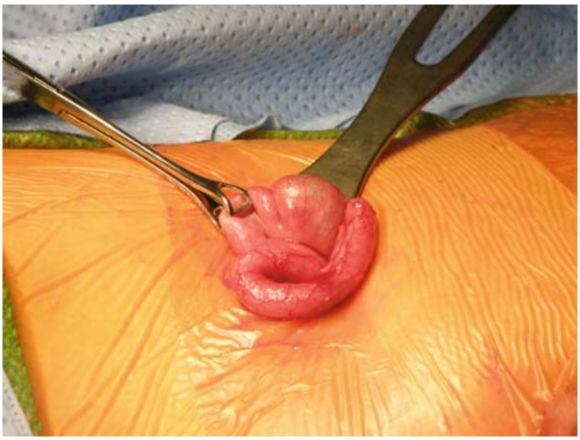

Fig. 18.1 After locating the cecum by following the tenia proximally, the cecum (*arrowhead*) and appendix (*arrow*), are shown after carefully being manipulated into the McBurney's incision in the right lower quadrant

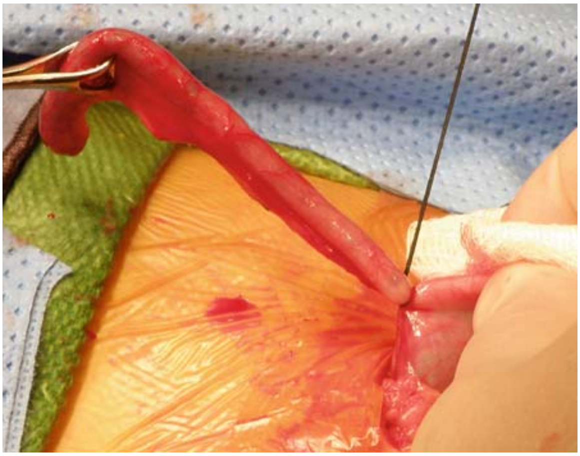

Fig. 18.2 The appendix has been freed from its mesentery by ligating and dividing the mesoappendix and appendiceal artery. After the base of the appendix is clearly identified, it is shown being ligated

doubly ligated with 2-0 silk or absorbable suture (Fig. 18.2). The appendix is amputated and sent to pathology for analysis. The exposed mucosa of the appendiceal stump is cauterized. "Dunking" of the stump with a purse-string suture around the base of the appendix is considered optional. Next, the patient's wound is irrigated with warm saline. The transversalis and peritoneum are reapproximated with a running 3-0 absorbable suture. The internal oblique and aponeurosis of the external oblique are closed with interrupted 0 absorbable sutures. The subcutaneous tissue is closed in layers and the skin is approximated with a 4-0 absorbable running or interrupted subcuticular suture. If the appendix is perforated or there is gross contamination, the subcutaneous tissue and skin are left open, dressed twice a day with saline moistened gauze, and closed in a delayed primary fashion several days later.

18.5 Laparoscopic Appendectomy

Preoperative preparation, including resuscitation and antibiotic prophylaxis, are similar to the considerations for open appendectomy. The patient is placed in the supine position, with right arm extended for intravenous access and blood pressure monitoring and left arm tucked at the patient's side. A urinary catheter is inserted in order to decompress the bladder, both to improve visualization of the appendix, and also to prevent bladder injury during trocar placement

The abdominal cavity is accessed via the open Hasson technique. The skin is incised transversely inferior to the umbilicus. Blunt dissection is carried down to the midline fascia. The umbilical stalk is grasped at its base with a penetrating clamp and elevated. A 1 cm vertical midline incision is made inferior to the umbilical stalk. The peritoneal cavity is entered sharply and 2-0 absorbable sutures are placed at either end of the fascial incision and used to secure the Hasson port in

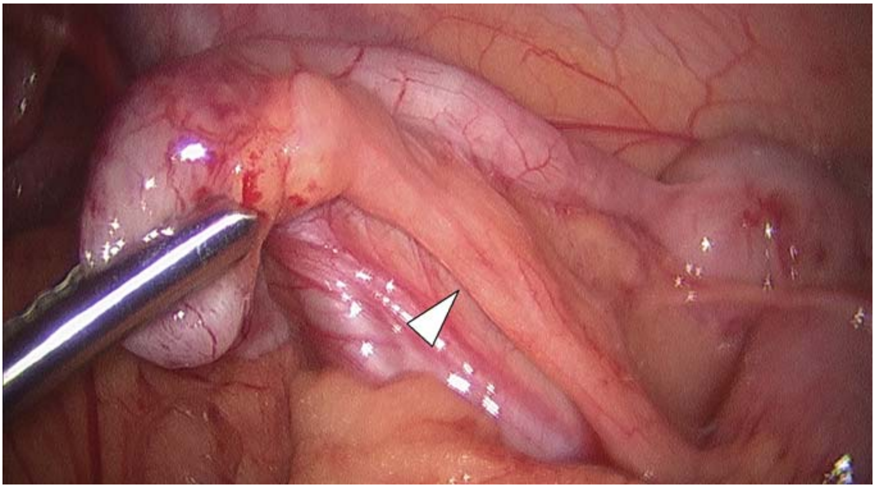

Fig. 18.3 In the laparoscopic approach, the appendix is grasped near its tip and retracted inframedially to expose the mesentery (*arrowhead*) for division by either the ultrasonic scalpel or a vascular stapler

place. A pneumoperitoneum is established to 15 mmHg pressure. A 5-mm, 30-degree camera is passed into the peritoneal cavity. A careful laparoscopic inspection is performed especially if the patient's presentation is atypical or other diagnoses besides appendicitis are being considered. Five-millimeter ports are placed under direct visualization in the inframedial and left infralateral positions. The patient is placed in slight Trendelenburg position with the right side up to facilitate visualization of the appendix and retraction of the small bowel out of the pelvis. The appendix is identified and gently grasped at or near its tip (Fig. 18.3). It is retracted in an inframedia fashion to expose the mesentery. The blood supply is divided with an ultrasonic scalpel (or a vascular stapler) (Fig. 18.4) and the appendix is divided at its base with a vascular stapler (Fig. 18.5). Dissection may be required to free the appendix due to adhesion to the omentum, abdominal wall, pelvis, or adjacent bowel. Retrocecal appendices, in particular, frequently require mobilization of the posterior lateral wall of the cecum to gain adequate exposure. Sometimes the distal appendix is fused to the wall of the cecum making dissection very difficult. In this scenario it is easiest to identify the proximal appendix, create a window in the mesentery near its base, and divide the appendix with the stapler first before taking the mesentery. Care should be taken to precisely place the stapler so that the appendix can be properly divided without taking any part of the cecal base. Once resected, the appendix is placed in a laparoscopic retrieval bag and brought out through the umbilical port or port site.

After hemostasis is assured at the staple line, the right lower quadrant, pelvis, and right subdiaphragmatic space are inspected for contamination and irrigated if necessary. Next, the 5-mm ports are removed under direct visualization and inspected

Fig. 18.4 The mesentery of the appendix is shown being divided with ultrasonic scalpel. The junction of the base of the appendix and cecum is indicated by the *arrowhead*

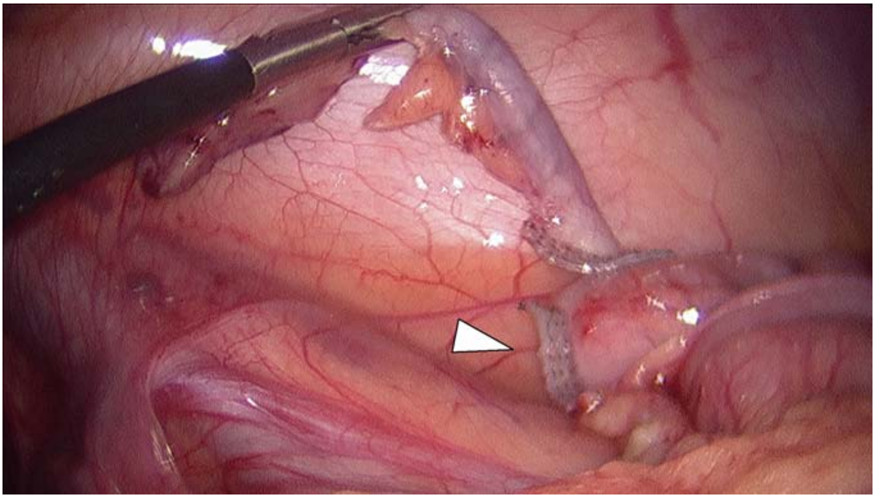

Fig. 18.5 The appendix is shown divided in a hemostatic fashion by a vascular stapler. The proximal staple line at the base of the cecum is indicated by the *arrowhead*

for bleeding. The pneumoperitoneum is then released and the infraumbilical port is removed. The previously placed traction sutures along with several additional 2-0 absorbable sutures are used to close the fascia. The skin incisions are closed with 4-0 absorbable subcuticular sutures and adhesive skin strips.

18.6 Postoperative Care

In uncomplicated cases, the patient often stays for overnight observation and can be safely discharged on postoperative day one after tolerating a regular diet. There is no evidence to support additional antibiotic use beyond routine preoperative prophylaxis in these patients [3]. Patients with complicated or perforated appendicitis, however, require more intensive antibiotic treatment. These patients have up to a 39% chance of developing postoperative infection, abscess, or ileus, compared to 8% for those with non-perforated disease [4]. Usually patients continue on broad-spectrum antibiotics until postoperative day 4. If the white blood cell count and C-reactive protein levels are normal and the patient is doing well clinically, then the antibiotics are discontinued and the patient is discharged to home. If these levels are abnormal, treatment is continued until day 7. Usually, if these patients are not back to normal a week after surgery, a CT scan of the abdomen and pelvis is obtained. Accessible fluid collections are drained by interventional radiology. Otherwise antibiotics are continued for another 7–10 days and may be continued until the abscesses have resolved and white blood cell and C-reactive protein levels have normalized.

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Part V
Colorectal Surgery

Section Editor: Charles P. Heise

Chapter 19
Right Hemicolectomy

Matthew C. Koopmann and Charles P. Heise

19.1 Indications

Colon cancer or large adenomas are the major indications for right hemicolectomy, as it is the most appropriate oncologic resection. Though *adenocarcinoma* account for the great majority of colon cancers, other tumors such as carcinoids, lymphomas, and leiomyosarcomas may rarely occur. Right hemicolectomy is also the procedure of choice for appendiceal neoplasms (adenocarcinoma, appendiceal lymphoma) involving the cecum or mesentery [1] and appendiceal carcinoid tumors larger than 1.5 cm or smaller than 1 cm with extension into the mesoappendix [2].

Benign conditions may also be treated by right hemicolectomy. These include Crohn's disease (although ileocecectomy is often sufficient), ischemia, trauma, right-sided diverticulitis, and volvulus. Colonic resection for benign disease differs from resection for malignant disease in that the extent of resection usually involves only grossly involved bowel and mesentery, whereas resection for malignant disease requires en bloc removal of the cancerous bowel with wide margins and the draining mesenteric lymph nodes. This chapter will describe right hemicolectomy for malignant disease.

Right hemicolectomy can be performed as an open procedure or as a laparoscopic-assisted procedure. The safety and efficacy of laparoscopic colectomy for colon cancer has been established by recent randomized controlled trials such as the North American-based COST Trial, which showed equivalent oncologic outcomes and complication rates between open and laparoscopic colon resections for cancer, with the benefit of a reduced hospital length of stay [3]. The decision to use an open or laparoscopic approach should be made based upon surgeon's experience and patient factors.

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19.2 Preoperative Preparation

Colon cancer may be asymptomatic and discovered as a result of screening programs or become symptomatic due to bleeding, obstruction, or metastatic disease. Both symptomatic and asymptomatic proximal colon cancer is definitively diagnosed by colonoscopy. For smaller lesions, it is important during colonoscopy that the endoscopist marks the site of the lesion via India ink tattoo, to facilitate accurate intraoperative localization during resection (especially important if approached laparoscopically). A chest x-ray and CT of the abdomen and pelvis is indicated to identify distant metastases. Preoperative carcinoembryonic antigen (CEA) may be obtained to assist in postoperative surveillance of recurrence. Though its use is currently being questioned [2], preoperative mechanical bowel preparation is still most commonly utilized at this time.

19.3 Positioning and Anesthesia

The patient is placed in the supine position. Arms may be tucked at the sides for a laparoscopic approach. Deep vein thrombosis (DVT) prophylaxis with subcutaneous heparin injection and sequential compression devices should be performed prior to the induction of anesthesia. General endotracheal anesthesia is the preferred method of anesthesia, although spinal anesthesia alone is feasible in high-risk cases [4]. The addition of a preoperatively placed thoracic epidural catheter may reduce postoperative pain, reduce narcotic requirements, and facilitate early return of bowel function [5]. A Foley urinary catheter should be placed and removed in the early postoperative period. Preoperative antibiotics with activity against anaerobic and Gram-negative and Gram-positive aerobic bacteria should be infused 30–60 min prior to incision and re-dosed as appropriately during the case.

19.4 Description of the Procedure

19.4.1 Open Right Hemicolectomy

The incision is made in the midline of the abdomen from just above to just below the umbilicus. A right transverse incision may also be used, especially for smaller proximal tumors. The subcutaneous tissues and linea alba is divided using electrocautery, the peritoneum is elevated by DeBakey forceps, and the peritoneal cavity is entered sharply with a scalpel or Metzenbaum scissors.

Upon entering the abdomen, a self-retaining retractor may be used to enhance exposure. The liver is examined for evidence of metastatic spread and the tumor is located, however, manipulation of the tumor should be minimized. The peritoneal reflection lateral to the cecum is incised and the terminal ileum is mobilized off the retroperitoneum. This dissection is continued distally along the lateral right colon

and up to the hepatic flexure using electrocautery, making sure to avoid the right ureter as it passes anterior to the right common iliac bifurcation It is necessary to identify the duodenum during mobilization of the hepatic flexure from the retroperitoneum, as the second and third portions may be injured by electrocautery during this step (Fig. 19.1). Theduodenum is kept posterior, mobilizing the colon anteriorly. The vessels contained within the hepatocolic ligament should be ligated and divided. This completes the mobilization around the hepatic flexure (Fig. 19.2).

The omentum is then freed off the transverse colon at the distal resection site and divided using the clamp and tie technique to include as part of the resection specimen. The resection site should be chosen to allow at least a 5–10 cm distal resection margin [6]. A window is created in the mesentery adjacent to the distal transection site. The marginal artery of Drummond is ligated and divided, and the transverse mesocolon is divided with electrocautery to the middle colic vessel bifurcation. The right branch of the middle colic vessel is ligated and divided at its origin and the left branch is spared (for lesions at the hepatic flexure or proximal transverse colon, the right hemicolectomy may be extended to include ligation of the middle colic vessels at their base and resection of the proximal and mid-transverse colon). The right colic vessels are identified, ligated, and divided. The mesentery is further divided inferiorly to the base of the ileocolic vessels (Fig. 19.3), whichare ligated with a

Fig. 19.1 After complete mobilization, the right colon can be retracted medially to expose the underlying retroperitoneal structures. Dissection at the hepatic flexure must be made carefully in order to avoid injuring the second and third portions of the duodenum

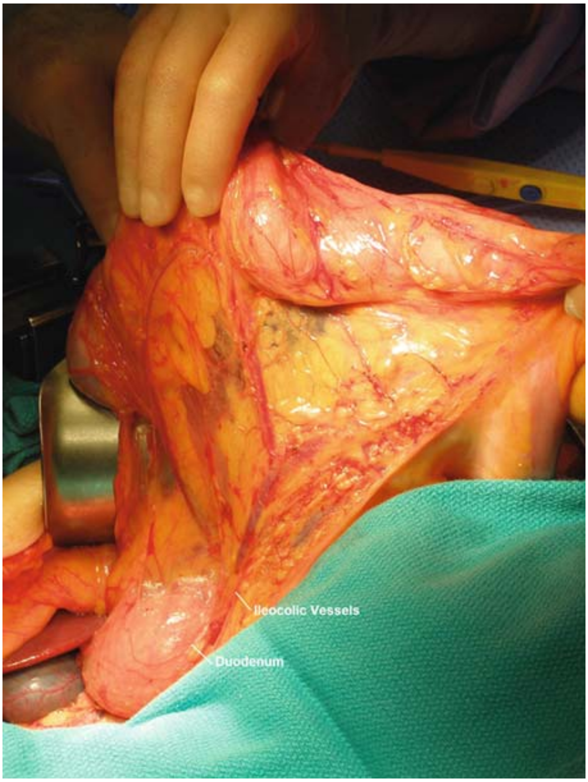

Fig. 19.2 This image demonstrates the fully mobilized right colon elevated medially and anteriorly out of the abdomen. Note the third portion of the duodenum and its proximity to the Ileocolic artery

heavy suture ligature and divided. The remaining small bowel mesentery is ligated and divided up to the terminal ileum. An area of the terminal ileum at least 5–10 cm proximal to the ileocecal valve is identified as the proximal margin (though a larger margin may be included for cecal tumors). At this point the mesenteric resection is complete and preparation should be made for the ileocolic anastomosis.

The ileocolic anastomosis can be created using a side-to-side stapled approach. We describe a linear cutting stapler approach. The remaining proximal ileum and transverse colon are aligned in a side-to-side fashion. The viable margins can usually be visualized easily. Two enterotomies are then created (one in the colon and one in the ileum) at the edge of the non-viable regions and a 75 mm linear stapler is passed through the enterotomies (Fig. 19.4), assembled, and deployed to create a side-to-side stapled ileocolic anastomosis. The staple line is inspected for bleeding and the anterior and posterior staple lines should be offset in order to prevent closing the staple lines on top of each other. A 60 mm thoracoabdominal (TA) stapler is then used to complete the anastomosis by stapling transversely across both limbs of viable bowel to include the enterotomy site in the resection (Fig. 19.5). Thebowel is divided on the stapler with heavy scissors. The specimen is inspected on the back table and sent to surgical pathology for further evaluation. The staple line may be reinforced with interrupted imbricating sutures. The mesenteric window

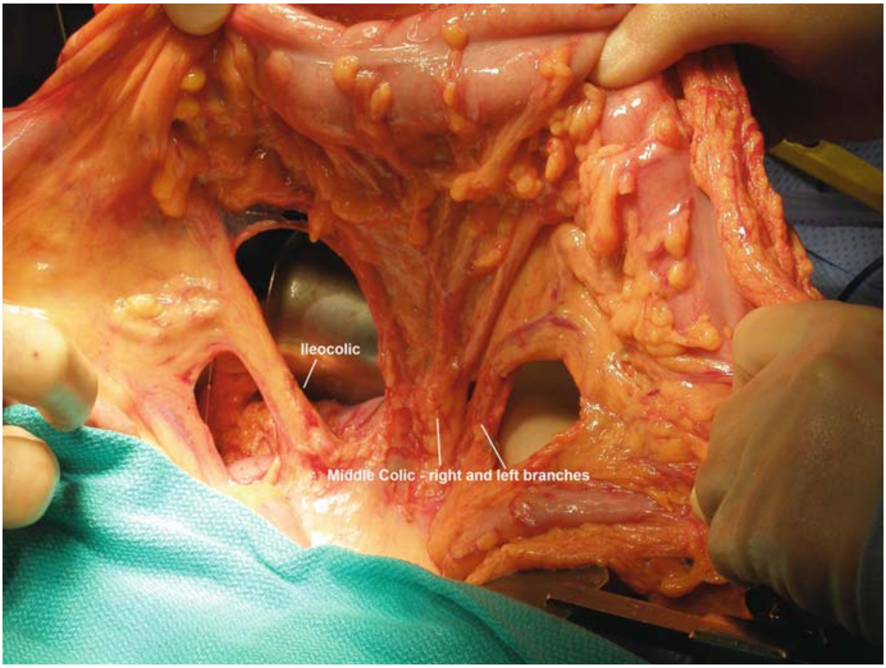

Fig. 19.3 The mesentery of the right and proximal colon is divided. Generally, the ileocolic, right colic, and right branch of the middle colic vessels are divided as demonstrated in this picture. When the resection is for malignancy, the right colic and ileocolic arteries are ligated close to their origin. This allows for a more complete lymph node sampling

may be closed with running absorbable sutures to prevent internal hernia. The bowel is then returned to the abdominal cavity and the abdomen is irrigated, inspected for bleeding, and the midline fascia closed with running absorbable sutures followed by skin closure.

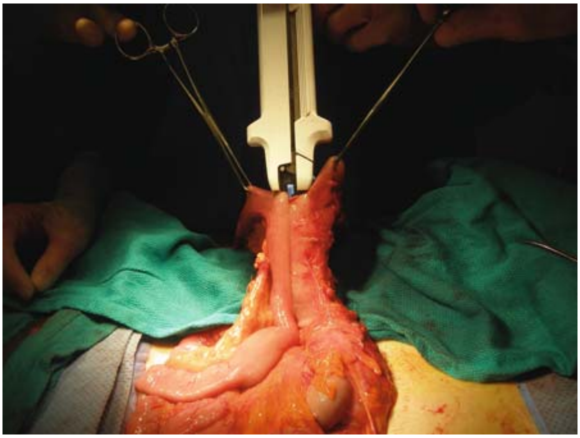

Fig. 19.4 The stapled side-to-side anastomosis begins with enterotomies being made in the ileum and colon. A 75 mm linear, cutting stapler is introduced and assembled. When the stapler is fired, an antimesenteric side-to-side anastomosis is created

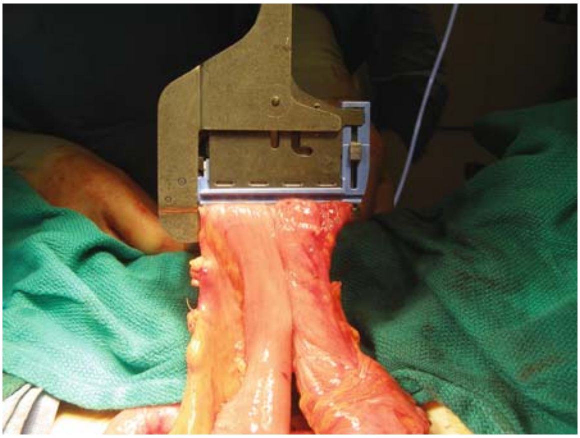

Fig. 19.5 The side-to-side anastomosis is completed by closing the common opening created by the linear cutting stapler. A transverse, non-cutting stapler is placed across the bowel to include the previous enterotomies, the jaws are closed, and the stapler is fired. Heavy scissors are used to cut the resected bowel from the staple-line, and the stapler is disengaged

19.4.2 Laparoscopic-Assisted Right Hemicolectomy

The indications, preoperative preparation, and positioning for laparoscopic right hemicolectomy is the same as for the open approach (arms may be tucked at the sides). General endotracheal anesthesia must be used due to the use of pneumoperitoneum. Prior colonoscopic marking of the colon lesion with India ink tattoo may be necessary for smaller lesions to facilitate intraoperative identification.

Abdominal access may be made via the open "Hasson" approach as follows: a 1 cm vertical, supraumbilical incision is made with dissection to the linea alba. The abdomen is then entered sharply and 2-0 Vicryl stay sutures are placed through each fascial edge. A 12 mm blunt Hasson trocar is inserted into the abdomen and the stay sutures are used to secure the Hasson trocar. A laparoscope is introduced to confirm the absence of visceral or vascular injury. The abdomen is insufflated with carbon dioxide gas to a pressure of 15 mmHg. Two 5-mm trocars are inserted, one in the suprapubic midline and one in the left lower quadrant under laparoscopic visualization. (A third 5-mm port may be used in the left upper quadrant as needed.) The abdomen is inspected for metastatic disease or adhesions and the colonic lesion is identified, avoiding this area with graspers. The colon may be mobilized using a lateral-to-medial or medial-to-lateral approach. The following describes a lateral-to-medial approach. The patient is placed in a steep Trendelenburg position with a tilt to the left. The terminal ileum is retracted anteriorly and superiorly, tenting the peritoneal attachments off the retroperitoneum and allowing it to be safely incised with electrocautery/scissors. The right ureter and gonadal vessels are identified at this time and kept posterior (Fig. 19.6). Mobilizationproceeds superiorly with both blunt and sharp dissection until the duodenum is encountered (Fig. 19.7). Atthis point, lateral mobilization along the right colon towards the hepatic flexure can be performed by incising the peritoneal attachments. As with the open procedure, it is important to keep mobilization of the hepatic flexure superolateral to the duodenum

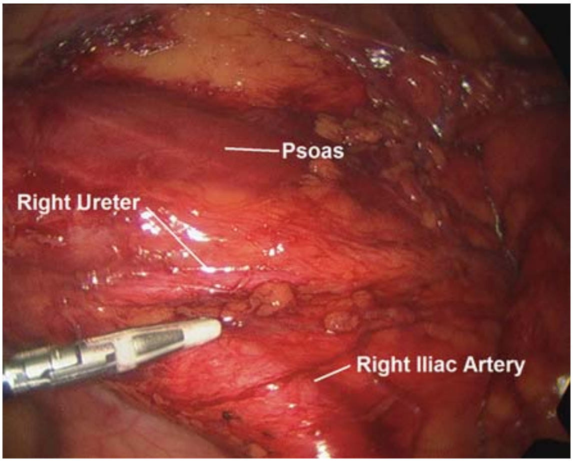

Fig. 19.6 During the lateral mobilization, the right colon is retracted medially, anteriorly, and cephalad. This exposes the retroperitoneal structures that lie posterior to the right colon. In this view you can see the psoas muscle laterally and the right gonadal vessels as they pass anterior to the right ureter. Care must be made to avoid injuring these structures during the laparoscopic mobilization

to avoid duodenal injury. After the peritoneal attachments of the hepatic flexure are divided, the hepatocolic ligament and right transverse colon omentum are divided using an energy-based vessel-sealing device. This is best facilitated by placing the patient in a steep reverse Trendelenburg position. The hepatic flexure of the colon is then freed and the anterolateral edge of the duodenum is again carefully identified. This completes the intracorporeal mobilization of the right colon. Next, the terminal ileum and ascending colon are grasped and retracted anterolaterally, placing traction on the ileocolic vessels (Fig. 19.8**).** Onceclearly identified, windows are made on either side of the ileocolic vessels near their origin. The vessels are then ligated using a vascular stapler or energy-based vessel-sealing device. The abdomen is then desufflated for specimen extraction and anastomosis.

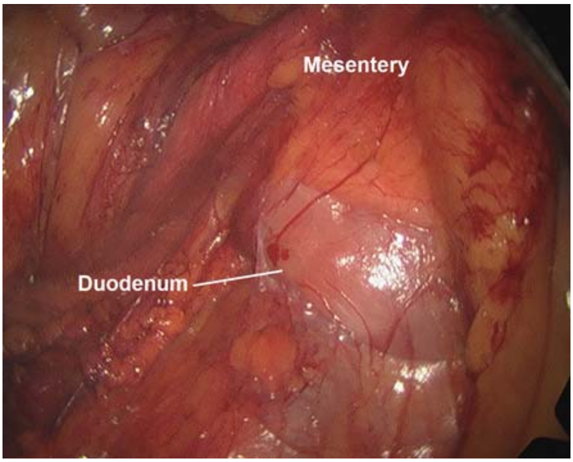

Fig. 19.7 During mobilization of the right colon the third portion of the duodenum comes into view as the colon is retracted cephalad and the mesentery is carefully dissected from the retroperitoneum. Dissection up to the duodenum completes the inferior-to-superior mobilization

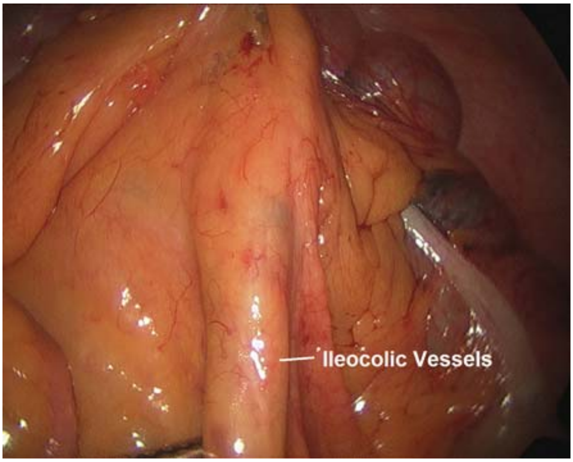

Fig. 19.8 As now mobilized right colon is elevated anteriorly, the ileocolic vessels can be visualized under tension. This allows creation of a mesenteric window on either side of the vessels prior to their ligation and division

A 3–6 cm vertical extension of the supraumbilical port incision is made around the umbilicus. A wound protector retraction device is placed. The mobilized ileum and right colon are then exteriorized. The remaining mesentery supplying the right colon is divided and the ileocolic anastomosis is performed as with the open procedure described above. Closure of the mesenteric window is usually not possible and therefore it is left open. Upon completion of the anastomosis, the bowel is returned into the abdomen and the fascia and skin closed as described previously.

19.5 Postoperative Care

Patients are admitted to a general care ward for postoperative care. Postoperative antibiotics are not indicated. Patients should be encouraged to ambulate and DVT prophylaxis should be continued. Non-steroidal anti-inflammatory drugs should be considered to minimize the need for narcotics. Diet can be advanced when bowel function returns. Patients typically require a 3–7 day stay in the hospital and are ready for discharge when they are tolerating a diet with adequate pain control and have return of bowel function. Potential complications may include wound infection, prolonged ileus, and anastomotic leak.

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Chapter 20
Sigmoid Colectomy

Matthew C. Koopmann and Charles P. Heise

20.1 Indications

Sigmoid colectomy is indicated for resection of malignant lesions in the sigmoid colon. As with any partial colectomy performed for malignant disease, sigmoid cancer resections should include the sigmoid mesentery to ensure en bloc removal of the tumor and its draining lymph nodes. Sigmoidectomy is also commonly indicated for benign disease, most commonly related to sigmoid diverticulitis. Diverticulitis accounts for one-third of all colectomies and resection is indicated after recurrent episodes or for complicated cases resulting in perforation, abscess, fistula, or stricture [1]. Other benign indications for sigmoidectomy include sigmoid volvulus and trauma. As with right hemicolectomy, in the elective setting, sigmoidectomy can be performed laparoscopically with equivalent outcomes for both benign and malignant diseases [2, 3].

20.2 Preoperative Preparation

Preoperative preparation is similar to other colon and rectal resections, see right hemicolectomy.

20.3 Positioning and Anesthesia

General endotracheal anesthesia is the preferred method of anesthesia. The addition of a preoperatively placed thoracic epidural catheter may reduce postoperative pain, reduce narcotic requirements, and facilitate early return of bowel function [4]. The patient is placed in the modified low lithotomy position after anesthesia is induced, with the legs in padded boot-type stirrups, minimal hip flexion, and adequate thigh

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abduction to expose the anus. Arms may be tucked for laparoscopic resections. Deep vein thrombosis (DVT) prophylaxis with subcutaneous heparin injection and sequential compression devices should be performed prior to the induction of anesthesia. A Foley urinary catheter should be placed to decompress the bladder and is usually maintained in the immediate postoperative period for fluid status monitoring. Preoperative antibiotics with activity against anaerobic and Gram negative and Gram positive aerobic bacteria should be infused 30–60 min prior to incision and re-dosed as appropriate during the case.

20.4 Description of the Procedure

20.4.1 Open Sigmoidectomy

A skin incision is made with a scalpel from the umbilicus to the symphysis pubis. This is carried through the subcutaneous tissue and fascia with electrocautery and the peritoneum is grasped with forceps, elevated, and opened sharply. The incision is then fully opened and the abdomen explored for evidence of disease outside of the sigmoid colon. A self-retaining retractor may be used to improve exposure. The mobilization of the sigmoid colon begins by incising the lateral peritoneal attachments, while staying anterior to the retroperitoneal fascia. The left ureter and gonadal vessels are identified and maintained posterolaterally to avoid injury to these structures during the medially directed sigmoid mobilization (Fig. 20.1). Once the sigmoid colon is mobilized, (Fig. 20.2) dissection is continued proximally with electrocautery. The splenic flexure of the colon may be mobilized if it is clear that further length will be necessary in order to complete a "tension-free" anastomosis. First, the renocolic ligament is incised, allowing the splenic flexure to descend, increasing the distance between the colon and the spleen. This allows safer transection of the lienocolic ligament, which should be made along the colon wall to prevent splenic injury. The omentum is divided from the distal transverse colon as necessary.

Upon completion of the mobilization, the ureter and the gonadal vessels are again identified posterolaterally prior to mesenteric division. For cases involving malignancy, the mesenteric division is taken at the root of the mesentery where the inferior mesenteric artery (IMA) and vein (IMV) are identified The IMA is dissected, suture ligated, and divided. The IMV, which is lateral to the IMA, is then divided separately. The dissection of the mesentery continues and may include ligation and division of the ascending left colic artery (LCA). Proximal ligation of the LCA helps to ensure adequate collateral blood flow to the proximal limb of the anastomosis from the left branch of the middle colic artery via the marginal artery of Drummond. The mesentery of the remaining colon is divided up to the bowel wall ensuring adequate mesenteric inclusion for cases of malignancy. The proximal and distal colon transections should be made in well-perfused bowel at least 5–10 cm

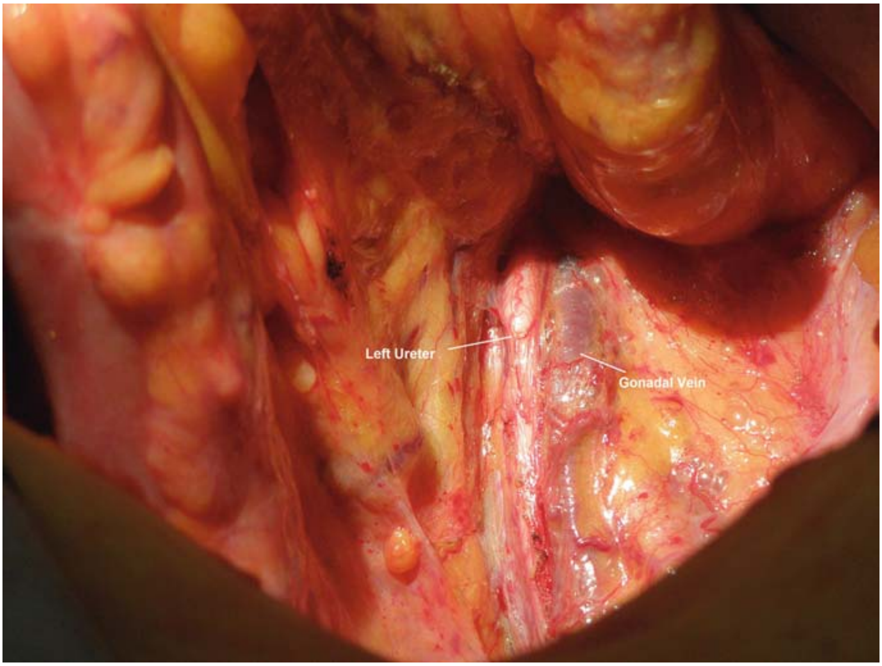

Fig. 20.1 The sigmoid is mobilized in a medial direction carefully incising along the peritoneal reflection. During this dissection the left ureter and gonadal vessels are kept posterolaterally to avoid their injury

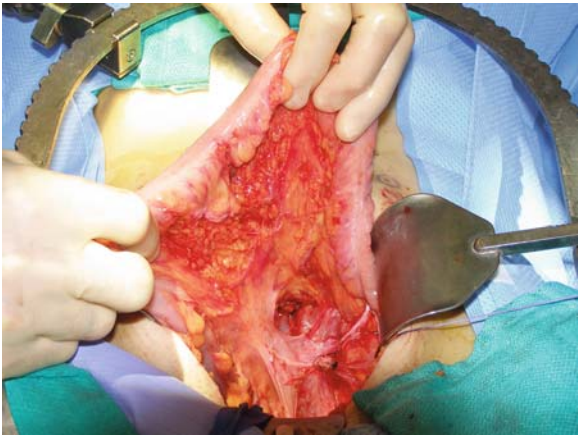

Fig. 20.2 In this picture, the sigmoid colon has been fully mobilized. Dissection can be continued proximally if needed to create a tension-free anastomosis or to include an adequate margin if resecting for malignancy

from the tumor (in cases of malignancy) or proximally in an area of normal compliant bowel and distally at the rectosigmoid junction (in cases of diverticular disease). Obviously, there should be adequate length preserved to allow a tension-free anastomosis. The proximal bowel is transected using a bowel clamp or a linear stapler.

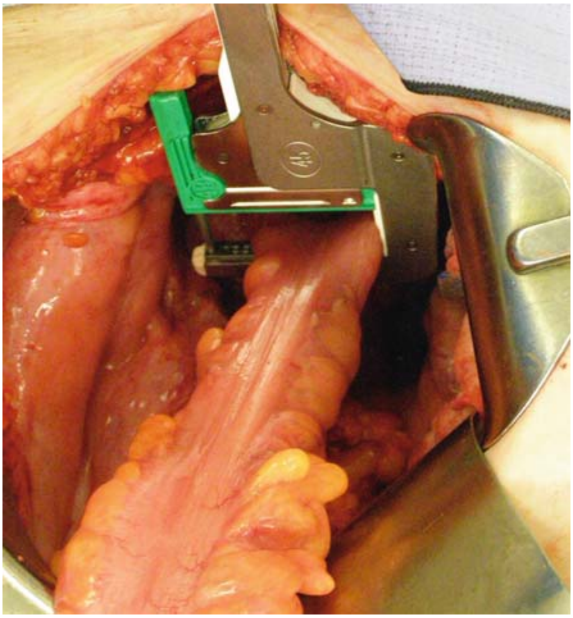

Fig. 20.3 Transection is demonstrated at the rectosigmoid junction (where the taenia coli fuse to become longitudinal muscle). This is especially important when resecting for diverticular disease. Here, a transverse, non-cutting stapler is utilized

The rectosigmoid junction is then transected with a linear cutting or transverse, non-cutting stapler in preparation for a double-stapled anastomosis (Fig. 20.3). The specimen is examined off the field to confirm lesion inclusion and margins and then sent to surgical pathology.

The anastomosis is begun by placing a purse-string suture at the proximal bowel clamp on the descending colon. The anvil shaft assembly of a circular stapler is then inserted into the lumen of the proximal bowel and the purse-string suture is tied to the groove on the shaft. The assistant then inserts the circular stapler transanally through the rectum and the center spike is delivered through the rectal wall adjacent to the linear staple line. The anvil shaft is attached to the center spike and the stapler is closed and activated. The stapler is opened, removed, and inspected for two complete tissue rings, ensuring full circumferential tissue stapling. The anastomosis is inspected for hemostasis, vascularization, and lack of tension. A leak test is performed by submerging the anastomosis in saline, digitally occluding the colon proximal to the anastomosis, and then insufflating air into the rectum using a rigid proctoscope, observing for bubbles from the anastomosis. Hemostasis is then assured, retractors are removed, and the abdomen is closed by re-approximating midline fascia in a running fashion followed by skin closure.

20.4.2 Laparoscopic-Assisted Sigmoidectomy

Pneumoperitoneum is established after peritoneal access via a supraumbilical open Hasson (10–12 mm) or Veress needle/5-mm optical obturator trocar technique.

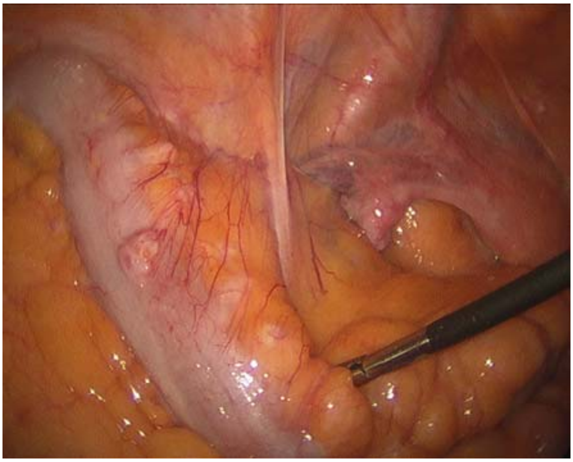

Fig. 20.4 When using the lateral-to-medial approach, the sigmoid colon is retracted medially to expose its lateral peritoneal attachments. These may then be incised with cautery, scissors, or other energy device

The laparoscope is inserted and the abdomen is inspected for evidence of injury to underlying bowel or vascular structures. A 5-mm left lower quadrant port, a 5-mm suprapubic port, and a 10–12-mm right lower quadrant port are then placed under 30° laparoscopic visualization. The patient is then placed in steep Trendelenburg position to begin the dissection at the sigmoid colon. The sigmoid colon is retracted medially and its lateral peritoneal attachments are incised (lateral-to-medial approach) (Fig. 20.4). The left ureter is identified and preserved lateral to the dissection plane (Fig. 20.5). The left colon is further mobilized by incising the lateral peritoneum reflection (white line of Toldt) as necessary (Figs. 20.6 and 20.7). Once the splenic flexure is encountered, its varying attachments are taken down if further colon mobilization is required. The renocolic ligament should be divided

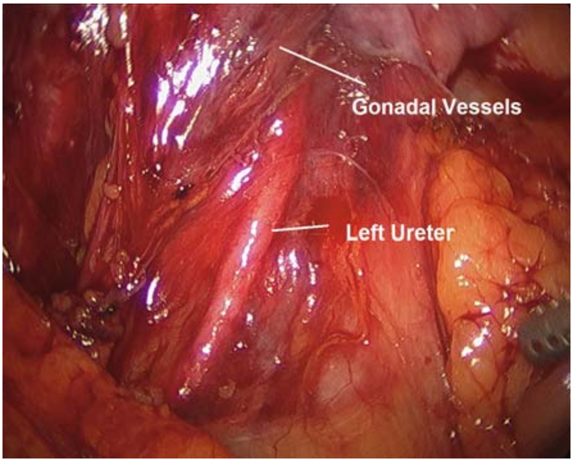

Fig. 20.5 The gonadal vessels are seen passing anterior to the left ureter. These structures are kept lateral to the dissection plane and should be identified during laparoscopic mobilization of the sigmoid colon

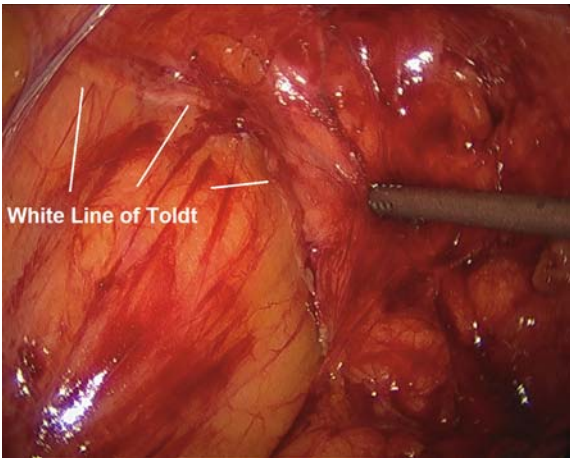

Fig. 20.6 The white line of Toldt is shown here. This lateral peritoneal reflection is incised to mobilize the sigmoid colon and stay within the proper dissection plane

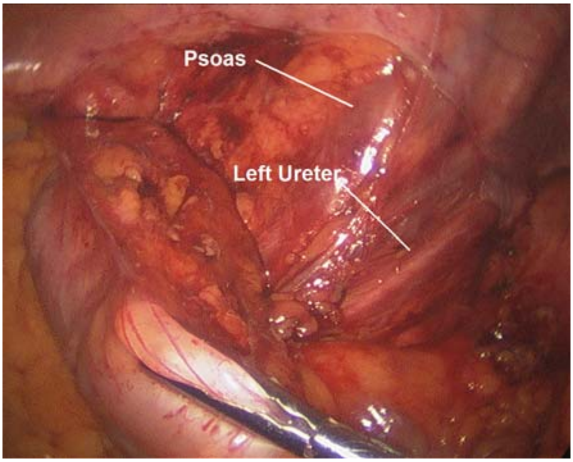

Fig. 20.7 After the lateral peritoneal reflection is incised and the colon mobilized adequately, the sigmoid may be retracted medially and the retroperitoneal structures are again identified. Whenever feasible, adjacent peritoneal attachments should be utilized for grasping rather than the colon itself to avoid inadvertent injury

first to allow the colon to descend away from the spleen. Next the lienocolic ligament is transected close to the colon wall. Finally, the omental attachments to the distal transverse colon are divided, completing mobilization of the splenic flexure.

Next, the IMA is identified near its origin at the aorta. An incision is made in the peritoneum of the sigmoid mesentery and the hypogastric nerves are identified. These are swept posteriorly to prevent their injury during IMA ligation and the IMA and IMV are then divided (in cases of malignant disease) utilizing a bipolar vessel-sealing device or laparoscopic vascular stapler. Continuing to protect the hypogastric nerves, the mesentery of the upper mesorectum is then divided from the transected IMA toward the rectosigmoid junction, identifying and dividing the superior rectal vessels during the dissection. Alternatively, this dissection and vessel ligation can be completed first (medial-to-lateral approach) followed by incising

the remaining lateral peritoneal attachments. For benign disease, the IMA and IMV may be preserved and mesentery divided closer to the colon. Once the rectosigmoid junction is encountered and cleared of mesorectum, a laparoscopic linear stapler is inserted through the right lower quadrant port and the rectosigmoid junction is transversely stapled and divided. Alternatively, the colon may be stapled with a transverse stapler via a transverse suprapubic incision (see below).

A 4–8 cm suprapubic transverse or vertical periumbilical incision is made as an extension of the periumbilical or suprapubic port site. A wound protector is placed and the sigmoid colon is exteriorized. Any remaining colon mesentery is divided to complete the resection. The colon is then divided 10 cm proximal to the tumor (or free of the diverticulitis segment) after placing a Denis clamp. The sigmoid specimen is then examined off the operative field and sent to surgical pathology. A purse-string suture is placed at the proximal bowel clamp of the descending colon. The anvil of a circular stapler is placed into the lumen of the descending colon and the purse-string is tied. The anastomosis can then be performed directly via the suprapubic incision as already described, or if a peri-umbilical incision is utilized the colon with anvil intact is replaced into the abdomen, the fascia closed, and the abdomen re-insufflated. The circular stapler is inserted transanally through the rectum. The spike is delivered under laparoscopic visualization and the anvil is attached. The stapler is fired to complete the colorectal anastomosis and the rings are inspected. The pelvis is then filled with saline and a leak test is performed via a rigid proctoscope. The abdomen and pelvis are irrigated and all incisions are closed.

20.5 Postoperative Care

Postoperative care after sigmoid colectomy is similar to that after right hemicolectomy, as previously described.

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Chapter 21
Low Anterior Resection and Abdominoperineal Resection

Erik E. Johnson and Charles P. Heise

21.1 Indications

Low anterior resection (LAR) and abdominoperineal resection (APR) are the two primary operations for surgical resection of rectal cancer. The decision to perform one operation over the other is based primarily on the tumor location in relation to the sphincter complex. Low anterior resection involves resection of the tumor with a primary anastomosis to the remaining anorectum, thus maintaining intestinal continuity. It is usually reserved for tumors located between 4 and 16 cm from the anal verge. Abdominoperineal resection involves removing the tumor along with the anal canal and sphincter complex, creating a permanent end colostomy. To qualify for an LAR, both the tumor and the distal margin must allow preservation of the sphincter complex. Although LAR is preferred by most patients, damage to the sphincter complex with a very low anastomosis can create a poor functional result [1].

21.2 Preoperative Evaluation

Evaluation of the patient with rectal cancer begins with visualization of the tumor to assess location and provide biopsy via proctoscopy to confirm the diagnosis of adenocarcinoma. A complete colonoscopy allows one to visualize the remaining colon to assess for synchronous lesions. Local staging is also performed by transrectal ultrasound or MRI scan to assess the depth of tumor penetration into the rectal wall as well as assess for adjacent adenopathy. Tumors which invade the serosa (T3) or adjacent structures (T4) or where lymph nodes are visualized (N1, N2) may be amenable to preoperative (neo-adjuvant) chemoradiation [2–5]. A CT scan of the abdomen and pelvis and chest x-ray are performed to assess for metastatic disease, which most often occurs in the liver or lungs. A preoperative serum CEA level may

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also be helpful for postoperative monitoring. Physical examination, including digital rectal examination is an important part of the preoperative workup. Palpation of the tumor allows one to assess size, location, mobility, and determine fixation to surrounding structures. Even if the tumor is not palpable, digital exam may assist in assessment of preoperative sphincter tone/function, an important component when considering between a LAR and APR. Patients with poor sphincter function or pre-existing incontinence may be better served with an APR and end colostomy. For locally advanced tumors, patients should be warned that concomitant resection of the posterior vaginal wall, prostate, or other pelvic organs is possible. In addition, postoperative bladder and sexual dysfunction is not uncommon and should be included in the informed consent discussion. Though the decision between APR and LAR must be discussed prior, the patient should understand that in some cases this decision could only be made at the time of operation.

Prior to the procedure, meeting with an enterostomal therapist is helpful in determining optimal ostomy placement. Patients undergoing APR will have an end colostomy, while those undergoing LAR are often diverted with a temporary loop ileostomy, especially after low coloanal anastomoses or in the setting of neoadjuvant radiotherapy. Diversion has been shown in a large, randomized controlled trial to reduce the incidence of symptomatic anastomotic leak and reduce the related morbidity [6, 7]. Use of a preoperative mechanical bowel preparation is surgeon-dependent, but most commonly utilized. In the case of a bulky or re-operative tumor, preoperative placement of ureteral stents may be helpful to identify and protect the ureters.

21.3 Positioning and Anesthesia

Both procedures require general anesthesia. A Foley urinary catheter should be placed to decompress the bladder and is usually maintained in the immediate postoperative period for fluid status monitoring. Deep vein thrombosis (DVT) prophylaxis with subcutaneous heparin injection and sequential compression devices should be performed prior to the induction of anesthesia. The addition of a preoperatively placed thoracic epidural catheter may reduce postoperative pain, reduce narcotic requirements, and facilitate early return of bowel function [8]. Preoperative antibiotics with activity against anaerobic and Gram negative and Gram positive aerobic bacteria should be infused 30–60 min prior to incision and re-dosed appropriately during the case. The patient is placed in low lithotomy position with the legs in padded stirrups. Careful attention should be placed during positioning to avoid potential nerve or pressure injury. The patient's perineum should be accessible at the break of the table to facilitate the perineal portion of the procedure (APR) or for passage of the circular stapler (LAR). Irrigation of the distal rectum is sometimes performed prior to prepping and draping. Final confirmation of tumor location and level should also be performed at this time.

21.4 Description of the Procedure

Both operations begin with a lower midline incision. The tumor is palpated, if possible, as is the liver for evidence of metastatic involvement. The small bowel is usually packed into the upper abdomen away from the pelvis and a self-retaining retractor is placed. A Trendelenburg position further facilitates exposure of the pelvis. The sigmoid colon is retracted medially and the peritoneal attachments along the left lateral abdominal wall are carefully incised. The left ureter and gonadal vessels should be identified, which lie in close proximity to the mesentery of the rectosigmoid. The peritoneal attachments are further incised up to or including the splenic flexure, if necessary, in order to facilitate future tension-free anastomosis. Next, the rectosigmoid is retracted to the left to expose the mesentery. The inferior mesenteric artery (IMA) is then palpated and/or transilluminated to further identify its base and branches. A window is made behind the IMA and the hypogastric nerves are visualized and carefully kept posterior (Fig. 21.1). The vessel may be ligated distal to its ascending left colic branch ("low" ligation) or at the root of the aorta ("high" ligation). Similarly, the inferior mesenteric vein is ligated and divided. Finally, the distal sigmoid colon is divided, usually with a linear stapler and the proximal portion is replaced into the abdomen and retracted during the remaining pelvic dissection.

A total mesorectal excision is facilitated by retracting the divided colon anteriorly toward the pubis to identify the avascular plane posterior to the mesorectum

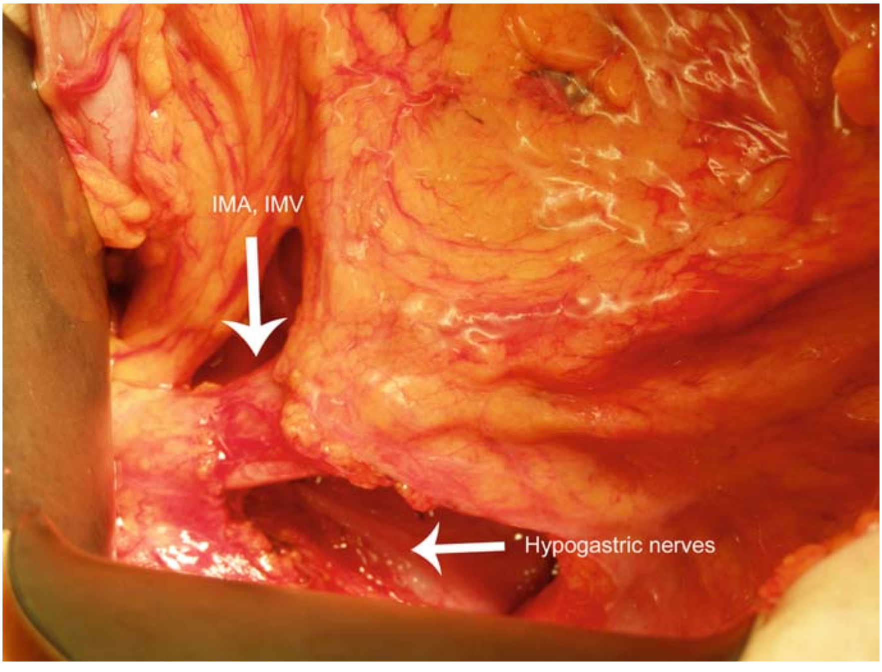

Fig. 21.1 A window is made behind the inferior mesenteric artery (IMA). The hypogastric nerves are identified and kept posterior

(Fig. 21.2). Incision of the areolar tissue posterior to the rectum along the endopelvic fascia is performed with electrocautery. This posterior dissection is continued down to the level of the pelvic floor (Fig. 21.3). Again, care is taken to identify and preserve the hypogastric nerves, which are important for postoperative sexual and urinary function. These nerves can be seen and palpated at the sacral promontory, dividing bilaterally, and following the pelvic sidewalls. The peritoneal reflection is incised bilaterally as well as anteriorly and dissection in the mesorectal plane is continued circumferentially. Laterally, supporting 'ligaments' that may contain the middle rectal vessels and splanchnic nerve branches are carefully divided with cautery, maintaining the proper plane. In males, the seminal vesicles are visualized and kept anterior to the dissection. Similarly, in females, the posterior vaginal wall can be visualized and is carefully dissected within the rectovaginal septum (Fig. 21.4). Preservation of the fascia propria, which envelops the specimen, prevents tumor spillage and has been shown to reduce local recurrence [5, 9, 10].

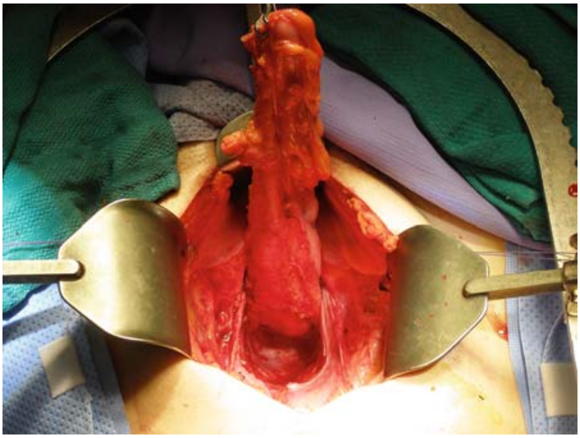

Fig. 21.2 The divided colon is retracted anteriorly to visualize the posterior, retro-rectal, avascular dissection plane

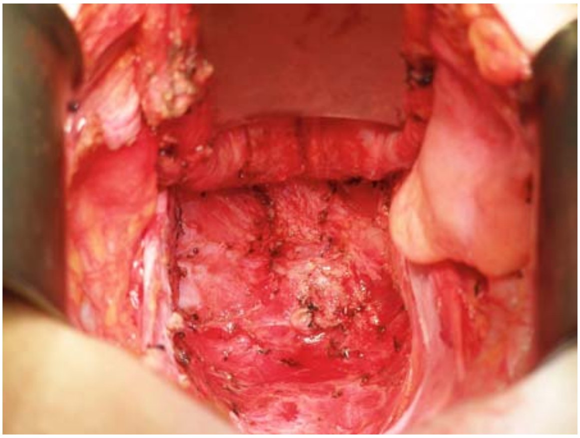

Fig. 21.3 The mesorectal dissection is carried down to the level of the pelvic floor. The hypogastric nerves are identified and preserved throughout the dissection

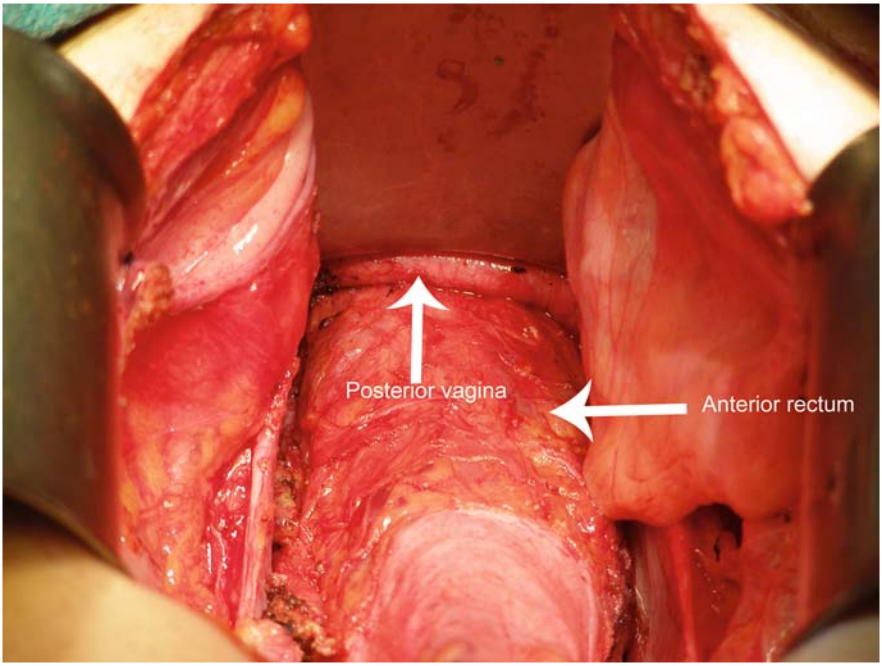

Fig. 21.4 In females, the dissection continues between the anterior rectum and the posterior vaginal wall, leaving the anterior mesorectum intact

After circumferential mobilization of the specimen, the low anterior resection and abdominoperineal resections differ.

21.5 Low Anterior Resection

For upper-third rectal tumors, dissection should continue so as to obtain a generous distal margin (5 cm has been suggested) [11]. For mid- or lower-third tumors, a complete or total mesorectal excision must be performed. At this point the tumor is palpated to determine whether a sphincter preserving operation is possible. A distal margin of 2 cm is customary, though less may be acceptable if an adequate margin can be obtained without compromising the sphincter complex [12]. An angled clamp is placed across the bowel distal to the tumor. At this point a rectal washout utilizing a dilute Betadine solution may be performed. Next, a transverse, non-cutting stapler (30 or 45 mm) is placed at the distal most portion of this dissection (Fig. 21.5) and the rectum is divided. Alternatively, the anorectum is divided within the anal canal to obtain an adequate margin and facilitate a coloanal anastomosis. The specimen is sent to surgical pathology after confirming an adequate distal margin.

Several options for reconstruction exist. In tumors of the proximal rectum, an end-to-end anastomosis is appropriate. This anastomosis can be either handsewn or

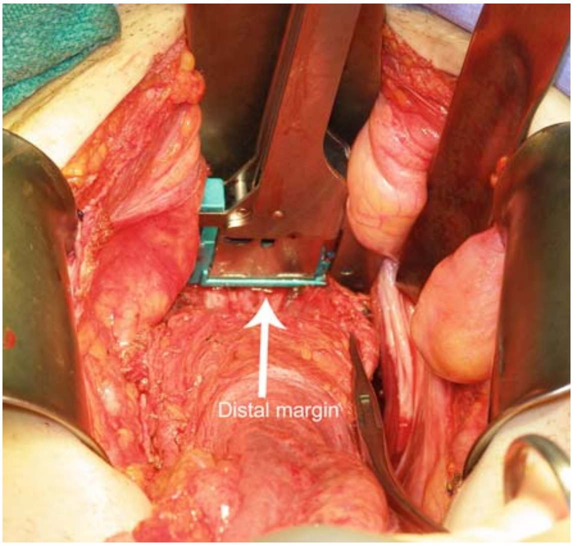

Fig. 21.5 When performing a low anterior resection (LAR), at the completion of the mesorectal mobilization, the rectum is transected with a margin beyond the level of the tumor utilizing a transverse, non-cutting stapler

fashioned via a circular stapler. To complete a double-stapled anastomosis, the anvil is introduced into the sigmoid/descending colon utilizing a purse-string technique. An assistant then inserts the circular stapler through the anus into the rectal pouch. The trocar is then carefully advanced through the cuff of the rectum (Fig. 21.6).

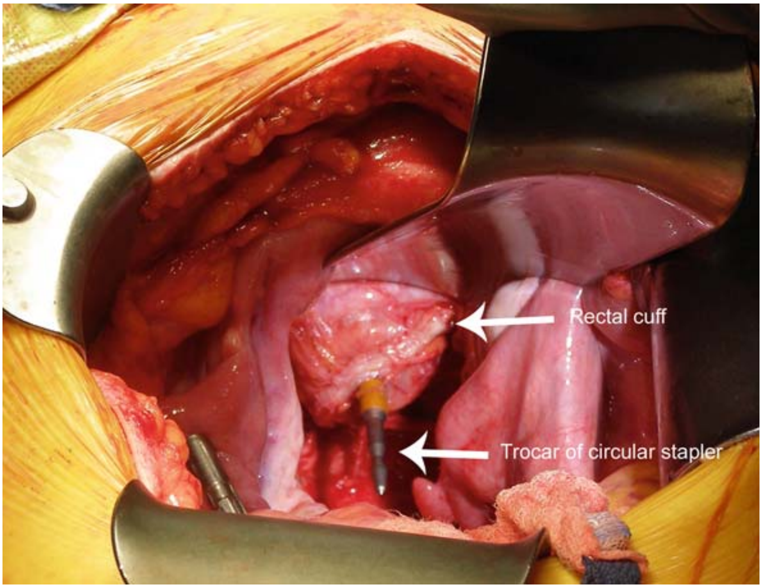

Fig. 21.6 For a LAR stapled anastomosis, an assistant inserts the circular stapler through the anus into the rectal pouch. The trocar is advanced until it is visualized penetrating the rectal cuff tissue and is fully deployed prior to attaching the anvil (proximal bowel)

The anvil is inserted onto the trocar and secured in place. The stapler is closed and fired, creating a circular, end-to-end anastomosis. Examination for leakage may then be performed by irrigating the pelvis, submerging the anastomosis, and insufflating the rectum with air via proctoscopy. If no bubbles are visualized, the staple line is secure.

For low rectal or coloanal anastomoses either a side-to-end or colonic J-pouch anastomosis offers some potential advantages, including a better blood supply and improved neorectal capacity, potentially reducing fecal incontinence, the frequency of bowel movements, and urgency [13, 14]. To create a J-pouch, the distal cuff of the sigmoid/descending colon is folded in a J configuration not to exceed a 5–6 cm length [15]. A linear cutting stapler is inserted into both lumens via a colotomy at the base and fired. An anvil is introduced into the opening at the base of the J and fastened with a purse-string suture (Fig. 21.7). The anvil is then connected to the trocar of the circular stapler as before. To create a side-to-end anastomosis, the anvil is inserted into the open lumen of the sigmoid/descending colon, which is then closed. A small colotomy is required to pull the female end of the anvil through the bowel wall. The anvil is again secured onto the trocar of the circular stapler for anastomosis. A diverting loop ileostomy (see Chapter 22) is usually utilized to protect these low rectal anastomoses or in cases following neoadjuvant radiotherapy to reduce both the incidence and morbidity of an anastomotic leak.

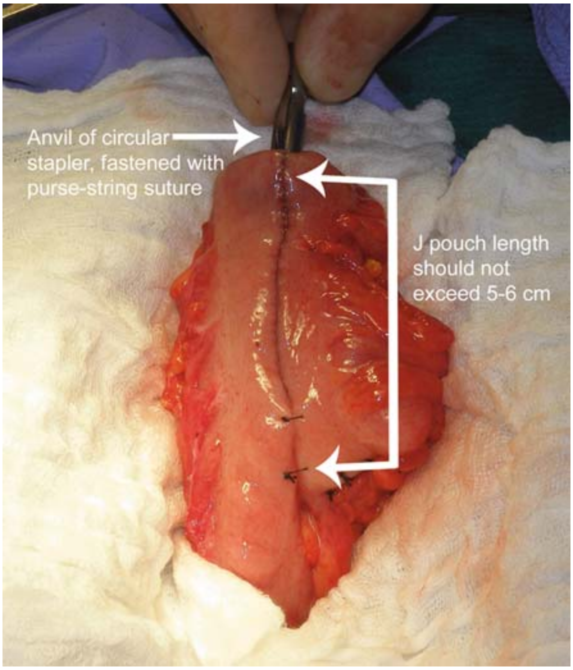

Fig. 21.7 A colonic J-pouch is illustrated. The sigmoid/descending colon is folded over on itself and a side-to-side J-pouch is constructed with a linear cutting stapler. The J-pouch length should not exceed 5–6 cm in order to optimize postoperative function. The anvil of the circular stapler is inserted at the apex utilizing a pre-placed purse-string suture

21.6 Abdominoperineal Resection

The APR procedure involves an en bloc resection of the distal rectosigmoid, rectum, and anus including the mesentery and mesorectum. An APR is utilized for low rectal tumors, which are close to or involve the sphincter complex or in cases where marginal continence already exists. In general, an adequate oncologic resection should not be compromised by attempts to preserve bowel continuity.

The abdominal phase of the APR procedure is identical to that of a LAR. After the complete abdominal mobilization of the rectum, the perineal phase begins. Often, the perineal phase is performed concurrently by a second surgeon. The perineum is exposed with a self-retaining retractor. An elliptical incision is made around the anus including the entire sphincter mechanism (Fig. 21.8). Dissection continues with cautery posteriorly until the coccyx is encountered (Fig. 21.9). The anococcygeal ligament is then divided and the previous dissected presacral space is entered just anterior to the coccyx. The levator muscles are hooked with the surgeon's finger and divided bilaterally with cautery. The dissection continues anterolaterally. In males, the anterior portion of the dissection is challenging to avoid injury to the membranous urethra and prostate. In females, retraction of the vagina facilitates separation of anterior rectum and posterior vaginal wall. Eversion of the specimen through the perineal opening may help facilitate the remaining anterior dissection plane (Fig. 21.10).

The excision is completed circumferentially and the specimen is removed through the perineal wound (Fig. 21.11). The levator ani muscles may be reapproximated in the midline if possible. The perineal incision requires closure in several layers to reduce wound complications (Fig. 21.12). The procedure concludes with creation of an end-sigmoid/descending colostomy, which is discussed separately (see Chapter 22).

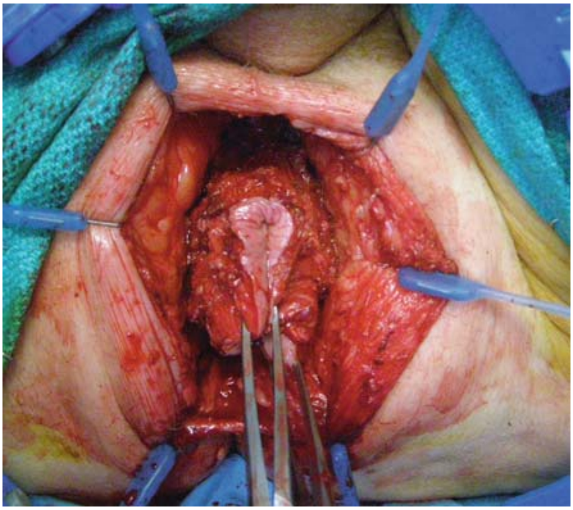

Fig. 21.8 The perineal portion of an abdominoperineal resection (APR) begins with an elliptical skin incision, including the anus and sphincter complex. Dissection continues circumferentially through the ischiorectal fat. A self-retaining retractor significantly improves visualization

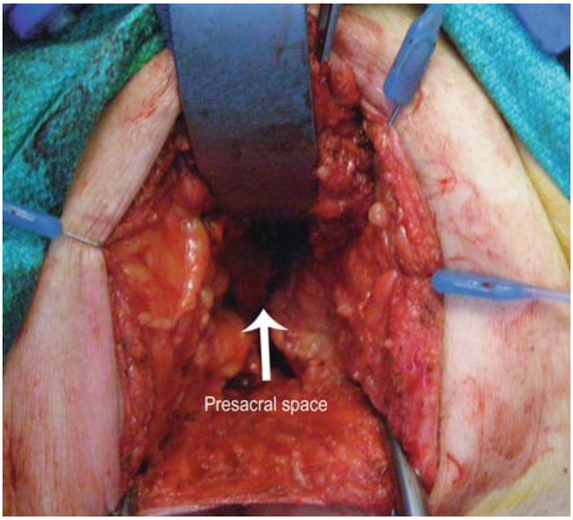

Fig. 21.9 The anus is retracted anteriorly and the posterior dissection proceeds to the level of the coccyx. The anococcygeal ligament is divided and the pre-sacral space is entered

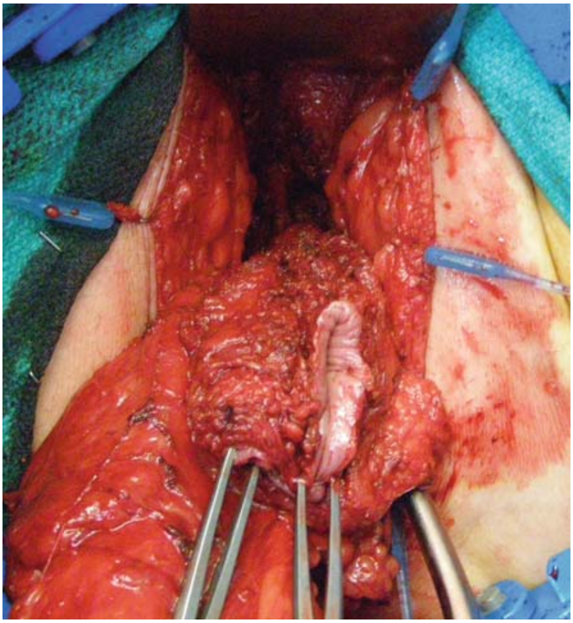

Fig. 21.10 With the posterior and lateral dissection completed, the specimen may be delivered through the perineal incision to better identify and facilitate the remaining anterior dissection plane

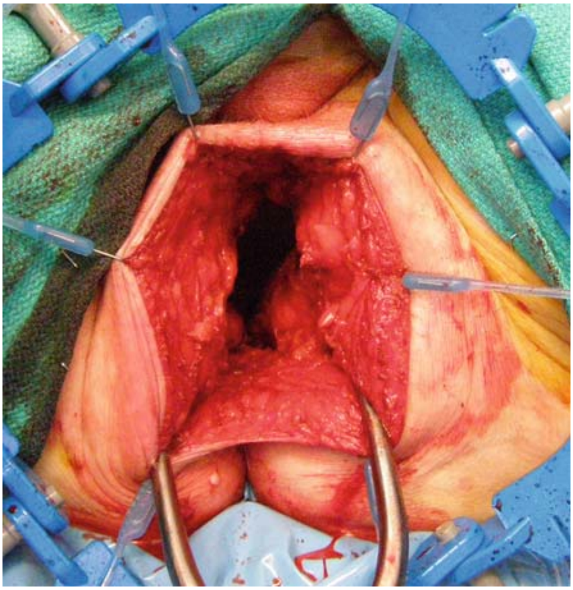

Fig. 21.11 After the dissection and excision is complete, the specimen is removed through the perineal wound leaving a direct communication to the pelvis

Fig. 21.12 The perineal wound should be closed in several layers with absorbable sutures. Finally, the skin is approximated vertically with interrupted sutures to accommodate wound drainage

21.7 Postoperative Care

In the immediate perioperative period, a urinary catheter is maintained for assessment of fluid status and avoidance of early voiding difficulties. The perineal wound should be inspected daily, to assess for breakdown or wound infection. After low

rectal anastomoses, the use of per rectum analgesics or suppositories is contraindicated. Patients should be encouraged to ambulate and DVT prophylaxis is continued. Diet is advanced when bowel function returns.

Based on tumor stage, there may be further need for postoperative radiation and/or chemotherapy. Long-term oncologic care requires monitoring for local and distant recurrence. Although no standard follow up regimen exists, most patients are followed with serum CEA levels, CT scans, and in LAR patients, proctoscopy or flexible endoscopy.

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Chapter 22
Stomas (Colostomy and Ileostomy)

Erik E. Johnson and Charles P. Heise

22.1 Indications

The term “ostomy” is derived from the Latin word “ostium,” which means mouth or opening. In the setting of abdominal surgery, the ostomy procedure refers to bringing a segment of small intestine or colon from the abdominal cavity out through the abdominal wall fascia and suturing it in place to the skin. By creating an opening in the bowel and suturing the bowel wall in place, the contents of the gastrointestinal tract can be safely drained into an ostomy appliance which is adhered to the skin.

Small bowel or colon may be used for this purpose. The name of the procedure reflects the segment of intestine used. For example, using colon creates a “colostomy,” and using ileum creates an “ileostomy.” Further, if the bowel is completely transected and a single portion of intestine is brought out of the abdomen, it is termed an “end” colostomy or end ileostomy. However, an intact loop of intestine can also be used. The bowel in this case is opened along its antimesenteric side, while preserving the remaining bowel wall, and both proximal and distal portions of the intestine are secured to the skin creating a “loop” ileostomy or colostomy.

The purpose of the ostomy is to divert the fecal stream. In cases of intestinal perforation or obstruction from a neoplasm, inflammatory bowel disease, or diverticulitis, the ostomy allows time for healing and sterilization of the contamination in the abdominal cavity [1]. An ostomy may also be used to divert the fecal stream away from a fresh intestinal anastomosis in the distal GI tract after a bowel resection and has been shown to reduce the rate of symptomatic leakage from low pelvic anastomoses in randomized trials [2]. In most cases, the procedure is temporary and a second operation is required to place the bowel back in continuity. However, in some cases, re-anastomosis is not possible (because of cancer, trauma, or poor anorectal function), in which case the ostomy will be permanent.

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22.2 Preoperative Preparation

Creation of an ostomy has a profound effect on patients' lifestyle and quality of life [3]. Therefore, thorough patient counseling preoperatively is essential to facilitate a smooth transition, both physically and mentally, to life with an ostomy. The location of the ostomy on the patient plays an important part in its overall function, and prior to the procedure, potential sites for ostomy placement should be marked on the abdominal wall. Often, this is performed by an enterostomal therapist or ostomy nurse. Factors to consider with placement include the patient's occupation, belt line, abdominal wall contour both sitting and standing, prior incisions, bony prominences, and abdominal girth. It should be easy to see and easily accessible to the patient. Skin folds and a pannus should be avoided due to difficulty with placement of the ostomy appliance. Stoma sites are also selected based on the segment of bowel to be utilized. Most end colostomies are located on the patient's left side in the left lower quadrant, whereas ileostomies are often in the right lower quadrant. The ostomy should be created through the rectus muscle to provide additional support. Most commonly, the ostomy is placed on the imaginary line from the umbilicus to the anterior superior iliac spine, through the rectus muscle, in either the right or left lower quadrant. However, if the belt line, skin folds, or pannus prevent easy access by the patient in this location, alternative sites may be chosen. In elective operations, it may be helpful to have the patient wear an adhesive ostomy appliance for a few days prior to the procedure to ensure optimal placement.

22.3 Positioning and Anesthesia

Depending on the indication for the procedure, the patient may be either in supine or low lithotomy position. Patients who are having a bowel resection with a planned rectal anastomosis should be placed in low lithotomy, whereas operations for more proximal bowel pathology can be approached in the supine position. The abdominal incision and exposure is dictated by the indication for the operation and the segment of bowel to be mobilized.

22.4 Description of the Procedure

Often, creation of the ostomy is the final step in a lengthy operation. However, extreme care is required during this portion of the procedure due to the significant morbidity from a poorly functioning ostomy. The segment of bowel is mobilized up to the abdominal wall by freeing attachments of the peritoneum and lengthening the mesentery. Like any intestinal anastomosis, adequate blood supply, lack of tension, and avoidance of pre-existing infection are key principles in its construction [4]. This may be difficult in cases of extreme obesity or a shortened, inflamed mesentery [5].

Once an adequate length of bowel has been mobilized, the ostomy begins with a circular skin incision measuring 2–4 cm in diameter at the pre-marked site (Fig. 22.1). Placing pressure on the undersurface of the rectus with a folded gauze laparotomy pad in the opposite hand prevents damage to the underlying viscera. Using electrocautery, a disk of skin is excised, leaving some of the subcutaneous fat behind, which will serve to support the bowel at the abdominal wall and prevent retraction. Blunt retractors are used to retract the incision and subcutaneous fat, exposing the underlying anterior rectus sheath (Fig. 22.2). Once the fascia is exposed, it is divided either vertically or with a cruciate incision (Fig. 22.3). The rectus muscle is separated in the direction of its fibers with simple retraction and not divided. The posterior sheath is exposed. The posterior fascia and peritoneum are divided similarly with electrocautery, with care to protect the underlying viscera. A general rule of thumb is that the defect in the fascia of the abdominal wall should admit two fingerbreadths, which allows adequate space for the bowel without vascular compromise. Very large fascial defects, which may be required for a loop colostomy for example, have a high rate of parastomal hernia formation [6, 7].

While keeping a finger through the opening to preserve the tract, a Babcock clamp is carefully placed through the hole in the skin into the peritoneal cavity. The clamp is placed onto the bowel segment and bowel is gently pushed through the fascial defect, with care to avoid pulling the intestine and tearing the mesentery. For loop stomas, a Penrose drain passed adjacent to the bowel wall allows gentle traction during placement (Fig. 22.4). The bowel should protrude 2–4 cm from the skin. At this point, the abdominal portion of the procedure is completed and the abdominal incision is closed, to avoid contamination when the bowel is re-opened during stoma maturation.

Fig. 22.1 The circular skin disk is excised. Note the hand pressure on the underside of the abdominal wall, which protects the bowel and properly aligns the skin opening with the planned fascia incision

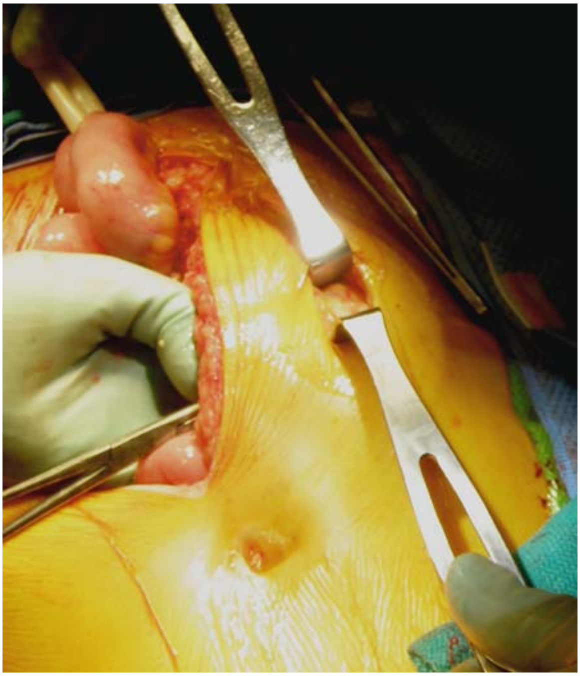

Fig. 22.2 The adipose is excised to some extent and then separated bluntly to expose the anterior rectus sheath

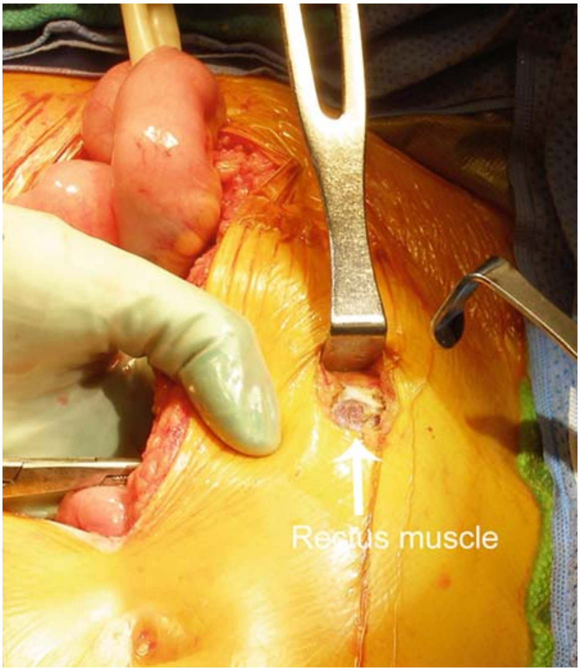

Fig. 22.3 The anterior rectus sheath is divided in a cruciate fashion with cautery to expose the rectus muscle. The muscle fibers are separated bluntly but not divided

Fig. 22.4 The bowel is brought through the fascia defect with a Babcock clamp or Penrose drain

The process of “maturing” the ostomy involves creating a spout with the bowel by everting the edges. This process was first described by Brooke and serves a number of important functions [8]. First, it helps direct the effluent into the appliance away from the skin, which is especially helpful for ileostomies, which produce high-volume output. The eversion technique also prevents stricture formation of the distal bowel and prevents leakage around the appliance. Next, the bowel is opened, either by excising the previous staple line (in the setting of an “end” ostomy) or opening the bowel primarily on the antimesenteric border for a loop ostomy. To properly evert the lumen, in the case of an end ostomy, three or four seromuscular absorbable sutures are then placed at each quadrant circumferentially around the bowel lumen. Each suture begins inside-out through the lumen of the bowel including the mucosa and serosa. The next bite is seromuscular at the bowel wall where the abdominal skin and protruding bowel meet and the final bite is through the dermis. Each suture is tagged with a hemostat. To evert the edge, the blunt end of a forceps is placed along the bowel wall and tucked under the stitch. The suture is gently pulled tight and tied as the bowel everts over the forceps and slightly intussuscepts (Fig. 22.5). Once the corners are secure, simple interrupted sutures are placed evenly around the lumen, starting inside-out through the entire thickness of the bowel and into the dermis. A clear stoma appliance is then placed over the everted bowel.

Maturation of a loop ostomy follows similar principles, although it requires securing two bowel lumens to the abdominal wall instead of one. In addition, since the bowel is only partially transected, the posterior bowel wall remains intact. In order to prevent this portion from retracting, a “bridge” may be used but is often not necessary. Usually made of a short segment of plastic or a rubber catheter, the bridge is passed under the intact bowel wall and secured in place with permanent suture to further support the bowel (Fig. 22.5). In cases of a loop colostomy where

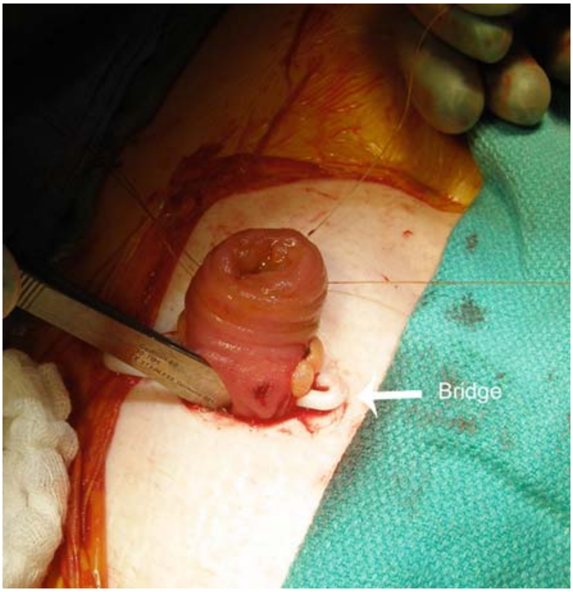

Fig. 22.5 Sutures are placed around the stoma in three or four quadrants, incorporating full-thickness bowel wall, then serosa, and then dermis. In this fashion the bowel wall is gently everted over the end of a forceps as the suture is tied. Note the optional bridge, which temporarily supports the loop ostomy (*white arrow*)

additional vascular division has been performed, the bridge must not occlude the marginal artery during placement. The bridge can usually be removed within 5 days of the operation.

22.5 Postoperative Care

A clear ostomy appliance is applied postoperatively to facilitate inspection of the bowel for viability. The output from the ostomy is directly related to the segment of intestine used. Left colon or sigmoid colostomies produce formed stool, whereas more proximal colostomies and ileostomies have a thin output consistency. It is not uncommon for ileostomy output to average 1–1.5 l per day, especially in the perioperative period [5]. Patients should be carefully monitored for dehydration and fluid resuscitated as needed. Ileostomy output is also rather acidic (pH 6.3) and therefore, accurate sizing and secure appliance placement should be utilized to avoid skin irritation [4]. Skin complications and dehydration are common postoperative sequelae and should be carefully assessed prior to patient discharge.

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Part VI
Anorectal Surgery

Section Editor: Gregory D. Kennedy

Chapter 23
Lateral Internal Sphincterotomy

Pasithorn A. Suwanabol and Gregory D. Kennedy

23.1 Indications

Anal fissure, or fissure-in-ano, is defined as a tear in the squamous epithelium of the anus distal to the dentate line. It is characterized by severe pain during and after defecation often causing a great deal of distress in affected individuals. Minimal bleeding can occur and is usually limited to bright red blood on toilet paper or the surface of stool [1]. Chronic anal fissures may present with perianal swelling, mucous drainage, or a sentinel pile [2].

Anal fissures occur most often in the posterior midline (Fig. 23.1), and less commonly in the anterior midline. While sporadic fissures can occur in the lateral location, in general, fissures in the lateral location should arouse suspicion of other diagnoses such as Crohn's disease, HIV/AIDS, tuberculosis, syphilis, or anal carcinoma.

There exists much debate about the etiology and pathogenesis of anal fissures with the most widely accepted causes being local trauma and ischemic ulceration [3, 4]. The resultant fissure causes internal anal sphincter spasm perpetuating a cycle of pain, fear of defecation, constipation, and further sphincter spasm [2, 5].

23.2 Preoperative Care

Prior to considering operative intervention, patients with acute fissures should be encouraged to increase fiber and water intake. Fiber alone will aid in the healing of nearly all acute fissures [6]. Additional measures to consider in the management of acute fissures include various medical therapies such as topical calcium-channel

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Fig. 23.1 Anal fissure

blockers and botulinum toxin injection. The goal of these therapies is to decrease internal sphincter pressure. The addition of these therapies may improve healing rates but the success rates vary [7–11]. Patients with fissures that persist for longer than 6 weeks or are associated with intolerable pain are candidates for surgical intervention [1, 3, 12]

23.3 Positioning and Anesthesia

The choice of positioning and anesthesia is surgeon-specific. Many use the prone-jackknife position for anal surgery. However, high lithotomy is a viable alternative. General anesthesia is usually employed although these operations can be performed under a direct anal block.

Lateral internal sphincterotomy (LIS) is the preferred surgical technique for chronic anal fissures [5]. LIS is associated with rapid healing and improved symptoms [13]. Long-term results demonstrate a success rate of greater than 95% [14]. Additionally, LIS is characterized by ease of procedure and minimal morbidity. However, postoperative complication of fecal or flatus incontinence has been demonstrated in 0–37.8% of patients and is a major concern in utilizing this technique as first-line treatment [1].

23.4 Description of the Procedure

Bowel preparation is not required for this procedure. Local or general anesthetic may be used at the discretion of the surgeon and anesthesiologist but general anesthetic is preferred. The patient may be placed in the lithotomy, prone, or left lateral position. A bivalve speculum is inserted into the anal canal with one blade placed at the anterior wall and the other blade at the posterior wall, holding the sphincters taut.

Either a closed or open sphincterotomy can be performed. In a closed sphincterotomy, the internal sphincter muscle is divided without incising the overlying anoderm. This operation is guided by the surgeon's nondominant index figure, which is inserted into the anus. First, the groove between the internal and external sphincter is palpated and the index finger of the nondominant hand is inserted into the anal canal. A generous amount of 1% lidocaine is injected into the intersphincteric groove following which a No. 11 scalpel is inserted with the blade parallel to the fibers of the internal sphincter (Fig. 23.2). The blade is advanced to the dentate line, approximately 1.5 cm, or to the level of the apex of the fissure, and the scalpel is rotated 90° toward the mucosa. The knife is then advanced toward the inserted index finger with a sawing motion until the internal sphincter is transected without penetrating the mucosal surface (Fig. 23.3). The scalpel is removed and any remaining fibers are transected when the area is palpated. This may be repeated on the opposite side of the anal canal if a deficiency cannot be palpated. Pressure may be applied to any bleeding. A foam sponge is then inserted to prevent hematoma formation, which will fall out during the patient's next bowel movement. Dry gauze over the wound can be removed on postoperative day 1. The patient may be discharged on the day of the procedure and should be instructed to continue taking bulk laxatives as well as provided with adequate pain control.

An open sphincterotomy is characterized by incising the anal mucosa to expose the internal sphincter muscle for division. A radial incision is made extending from

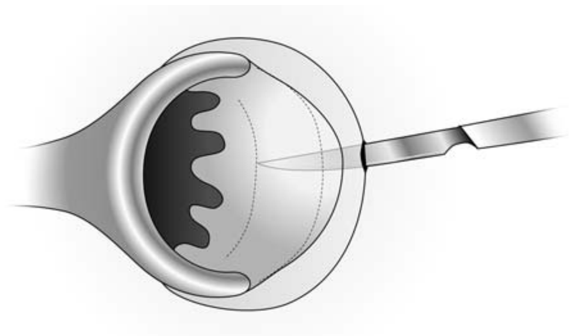

Fig. 23.2 Closed lateral internal sphincterotomy

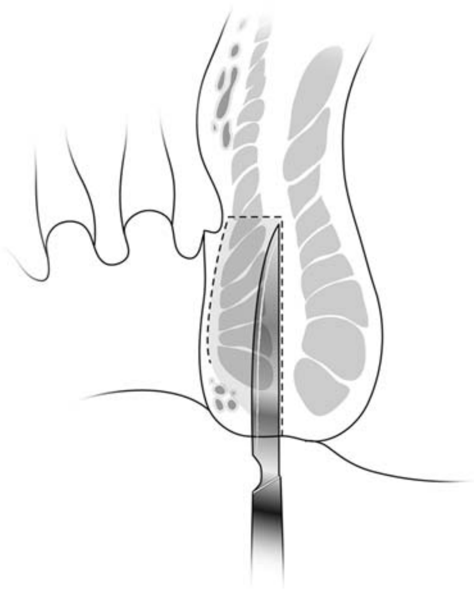

Fig. 23.3 Closed lateral internal sphincterotomy – coronal view

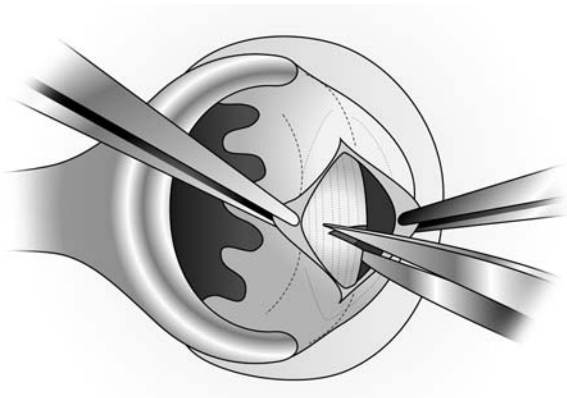

Fig. 23.4 Open lateral internal sphincterotomy

the intersphincteric groove to a point just distal to the dentate line (Fig. 23.4). The intersphincteric groove is identified and a small curved Kelly clamp is used to elevate the internal sphincter muscle. The fibers of the internal sphincter are divided to the level of the dentate line. Electrocautery is used to achieve hemostasis. The wound is generally closed in a running fashion using a fine chromic suture. Care must be taken to ensure no sphincter muscle is caught in the closure. Alternatively, the wound may be allowed to heal by secondary intention.

23.5 Special Postoperative Considerations

Postoperatively, all patients should be provided with adequate pain control. Additionally, all patients should be instructed to begin a fiber supplement. This will add bulk to the stool, which will ensure stretching of the anal musculature. Any wounds that were left open should be kept clean and dry. Finally, warm sitz baths can be used for comfort and to aid in perianal hygiene.

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Chapter 24
Cryptoglandular Disease

Erin S. O'Connor and Gregory D. Kennedy

24.1 Anorectal Abscess

24.1.1 Indications

Anorectal abscesses typically arise from obstruction of the anal glands and ducts, which communicate with the anal crypts located at the dentate line. The resulting infection begins in the space between the internal and external sphincters and can spread through the perianal spaces, forming pockets of purulent material. Locations of anorectal abscesses include (in order of frequency) (1) perianal, (2) ischioanal, (3) intersphincteric, (4) supralevator [1] (Figs. 24.1 and 24.2). Patients typically present with pain, palpable mass, fever, urinary retention, or sepsis. Predisposing factors may include diarrhea, trauma, or underlying inflammatory bowel disease. Once identified, usually on physical exam alone, drainage of the abscess cavity must take place as expediently as possible to minimize progressive symptoms and infectious complications.

24.1.2 Perioperative Care

24.1.2.1 Preoperative Preparation

CT or MRI imaging studies may be used to clarify the anatomical location of complex or atypical presentations, but may be deferred in typical cases. Examination under anesthesia may be the most efficient means to both confirm a questionable diagnosis and provide definitive treatment. Pre-procedure antibiotics are indicated for cellulitis or for patients with immune deficiencies, diabetes, prostheses, or cardiac valvular disease. In addition, patients with Crohn's disease may benefit from administration of oral metronidazole or ciprofloxacin [1, 2].

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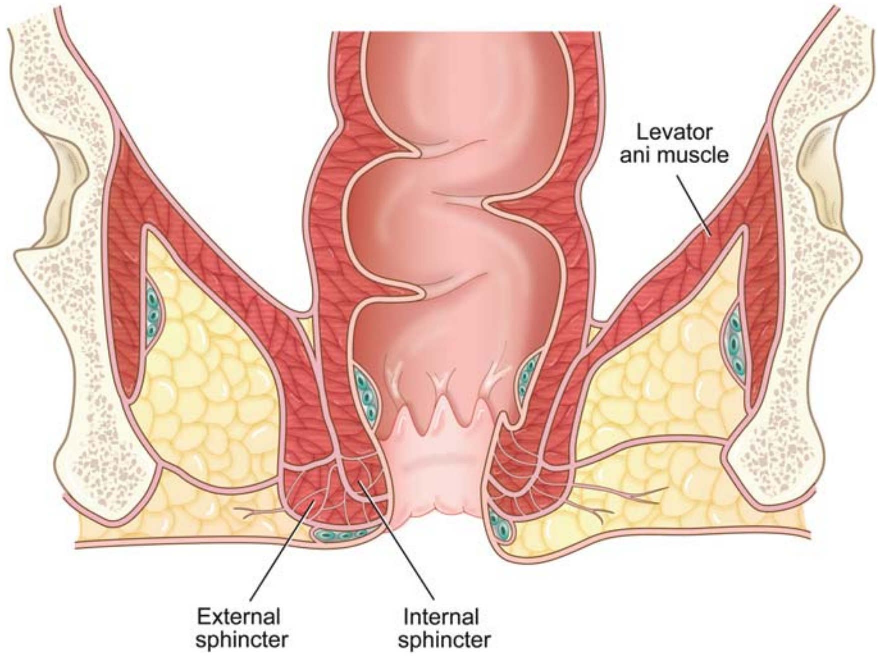

Fig. 24.1 Normal anorectal anatomy

24.1.2.2 Positioning and Anesthesia

The choice of positioning and anesthesia depends on the location of the abscess. Perianal abscesses are often palpable at the anal verge and may be effectively drained at the bedside in the decubitus position under local anesthesia. However, ischioanal, intersphincteric, and supralevator abscesses can be large and require examination under anesthesia to confirm location and extent. Therefore, these abscesses should be drained in the operating room in either lithotomy or prone-jackknife position. Regional, local with monitored anesthesia care, or general endotracheal anesthesia may be utilized, but must be adequate to allow sufficient relaxation to facilitate anoscopy and complete examination. Care should be taken to ensure adequate padding of the legs while in the lithotomy stirrups and sequential compression devices and compression hose placed on all patients.

24.1.3 Description of the Procedure

24.1.3.1 Anorectal Abscess Drainage

Candidates for bedside drainage include patients *without* (1) signs/symptoms of sepsis, including hypotension, high fever, and elevated WBC; (2) evidence of fistula or

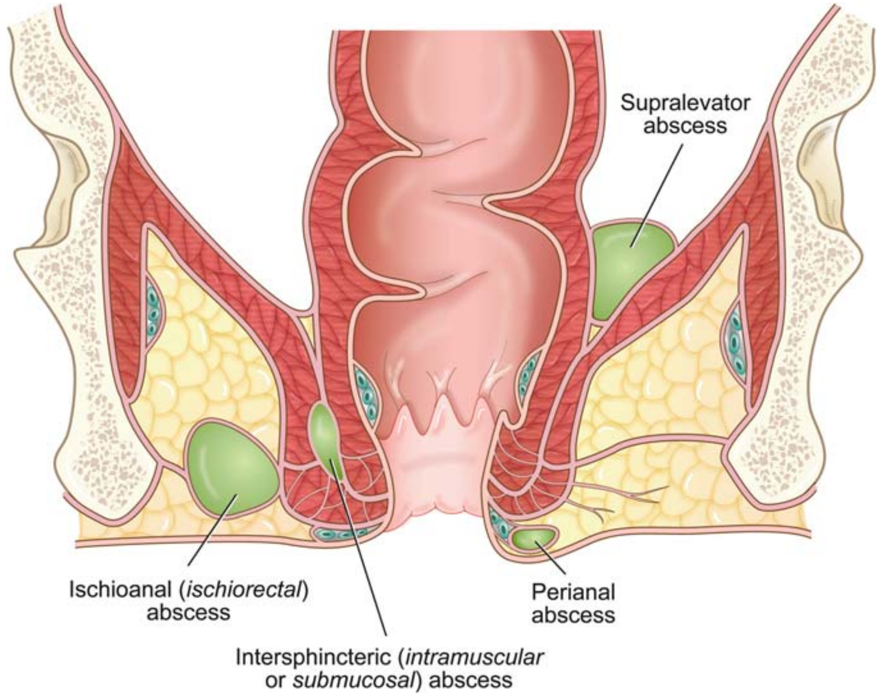

Fig. 24.2 Location of anorectal abscesses

fissure on physical exam; (3) history of IBD; (4) history of prior complex cryptoglandular disease; (5) history of recent abscess drainage or fistula procedure; (6) history of recent abdominal or pelvic operation; (7) CT evidence of complex disease, including supralevator or horseshoe type configuration. All patients should be initially examined in the decubitus position for an area of fluctuance in the perianal skin, generally with overlying erythema and occasional drainage. Once identified, those patients who are candidates for bedside drainage should have the area cleansed with chlorhexidine scrub. Lidocaine with epinephrine is infiltrated to provide local anesthesia to the overlying skin and IV or PO narcotics may be administered for pain relief. An 18-guage needle may be used to determine the location of the underlying purulent fluid. A generous cruciate incision is then made over the area of fluctuance using an 11 blade and the corners of skin are removed. Removing the corners of skin prevents early closure of the cavity and recollection of the abscess. Care should be taken to make the incision close to the sphincter complexes, in order to minimize the formation of complex fistulas with long tracts. Drainage of the cavity is facilitated by digital manipulation or lysis of intraluminal loculations with a Kelly clamp as needed. The cavity is then copiously irrigated with normal saline and explored to ensure no further areas of fluctuance require drainage. Sterile packing tape is used to lightly pack the cavity, which is then covered using sterile gauze.

Patients with any of the features concerning for complex abscess listed above should be brought to the operating room for examination under anesthesia and abscess drainage. Following anesthesia induction, a Foley catheter is placed; the patient is transitioned to either high lithotomy position in padded stirrups or to a prone-jackknife position, depending on surgeon's preference. The perineum is prepped and draped in a sterile fashion. Digital rectal examination is performed to evaluate for palpable mass, fissure, fistula opening, or other abnormality. An anoscope is then inserted and visual examination for fissure or fistula is carefully performed. The location of the abscess cavity is determined relative to the sphincter complex and the pelvic floor muscles.

- *Perianal abscess*: identified by bulging of perianal skin. A cruciate incision should be made and the abscess cavity drained and irrigated as described above.
- *Ischioanal abscess*: identified by bulging in the posterior or lateral anal canal. An incision should be made between the anal canal and the coccyx, incising the anococcygeal ligament, to facilitate drainage. Counter-incisions may be required over the ischioanal space on either side of the rectum. As described above, these incisions should be made lateral and close to the sphincter complexes.
- *Intersphincteric abscess*: identified by bulging in the posterior or lateral anal canal between or within the sphincter complex (intersphincteric). A transanal incision dividing the internal sphincter may be required for visualization and the incision should be widened to facilitate complete drainage as described above, while preserving as much sphincter mass as possible.
- *Supralevator abscess*: identified by palpation of mass on posterior or lateral rectum above the anorectal ring. Drainage route is determined by associated pathology:

    - If associated with ischioanal abscess, drain through cruciate incision on the perianal skin near the sphincter complex to avoid formation of extrasphincteric fistula.
    - If associated with intersphincteric abscess, drain through rectum to avoid formation of complex suprasphincteric fistula.
    - If associated with intraabdominal abscess, use imaging to guide choice of incision

Aspiration with an 18-guage needle may assist with locating secondary pockets. All cavity openings should be irrigated with saline and packed lightly with packing tape. Incisions on the perianal skin should be covered with sterile gauze dressing, as well.

Large cavities may require placement of a small mushroom-tip catheter to serve as a drain and maintain patency of the external tract. The external component of this drain should be kept relatively short and sutured in place to prevent dislodgement. Postoperatively, the patient should be taught how to flush the drain with sterile saline

and perform a gentle irrigation two times per day. The drain can be downsized once per week, as tolerated, until the cavity is small and manageable with local wound care.

24.1.4 Special Postoperative Considerations

All patients should begin sitz baths two times per day on postoperative day number two. Such a regimen ensures perianal hygiene and improves comfort of the area. Fiber or other bulk-producing agents should be introduced the next day as well to prevent diarrhea and improve hygiene.

24.2 Fistula-in-Ano

24.2.1 Indications

In approximately 50% of patients who experience a cryptoglandular abscess, an inflammatory tract develops between an internal opening at the dentate line and an external opening on the perianal skin forming a fistula-in-ano [2]. The location and course of the fistula typically reflects the location of the original abscess: (1) intersphincteric, (2) transsphincteric, (3) suprasphincteric, or (4) extrasphincteric [3] (Fig. 24.3). Patients present with drainage from the internal and/or external openings, either spontaneously or following I&D procedures for abscess. In general, the location of fistulous tracts and their external openings follows Goodsall's rule: anterior tracts follow a straight line to the external skin, while posterior tracts follow a curvilinear path.

24.2.2 Perioperative Care

24.2.2.1 Preoperative Preparation

Although most fistulae-in-ano represent complications of anorectal abscess, risk factors for underlying malignancy and inflammatory bowel disease must prompt consideration of a colonoscopy prior to operation. Surgical intervention for fistulae must be minimized for patients with IBD or low WBC counts. Techniques for identifying tract location include digital palpation, or imaging techniques such as endoanal ultrasound and MRI, with or without injection of dilute hydrogen peroxide. In one cohort, these methods successfully identified 61, 81, and 90% of fistulous tracts, respectively [4]. If local inflammation is minimal, enemas should be given the night before the procedure; complete bowel preparation is not needed. Preoperative antibiotics should be given prior to incision.

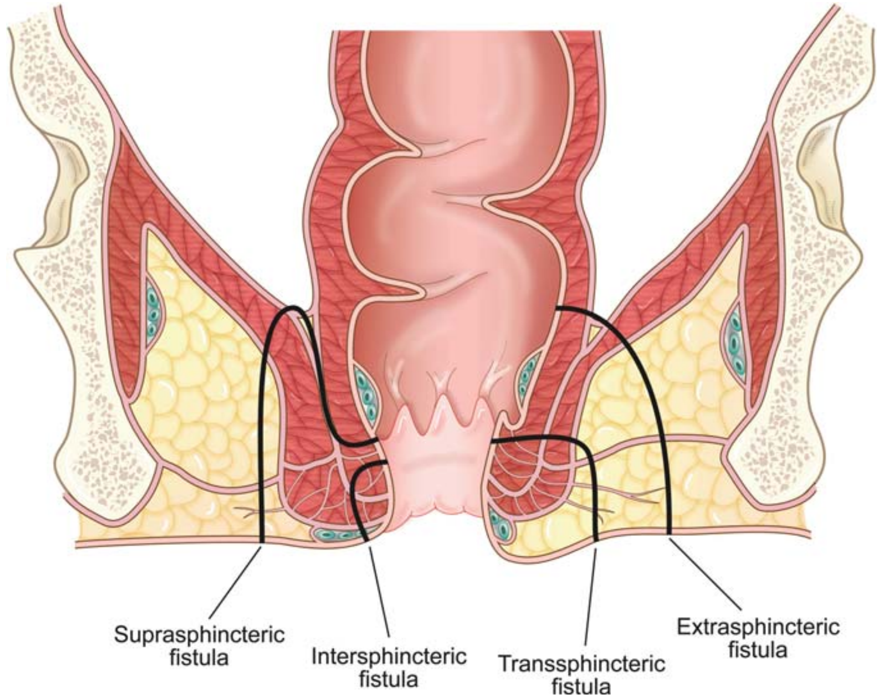

Fig. 24.3 Location of fistula-in-ano

24.2.2.2 Positioning and Anesthesia

Patients are placed supine on the operating table, in lithotomy or prone-jackknife position. Regional, local with monitored anesthesia care, or general endotracheal anesthesia may be utilized, but must be adequate to allow sufficient relaxation to facilitate anoscopy. Care should be taken to ensure adequate padding of the legs and other pressure points and sequential compression devices and compression hose placed on all patients.

24.2.3 Description of the Procedure

The patient is brought to the operating room and placed supine on the operating table. Following induction of anesthesia, the legs are placed in padded stirrups and elevated into lithotomy position. The perineum is prepped and draped in a sterile fashion. Digital rectal examination is performed to evaluate for mass, fissure, internal fistulous opening, or other abnormalities. In addition, the depth of the fistulous tract relative to the external sphincter is assessed in order to select the appropriate procedure: if less than 50% of the posterior or lateral external sphincter or less than

30% of the anterior external sphincter is superficial to the tract, a one-stage excision/fistulotomy may be considered. However, if a greater portion of the external sphincter is involved, staged repair with initial seton placement is recommended to minimize the risk of incontinence and stricture [5]. Other criteria state that if the internal opening is above the dentate line, the deep external sphincter is involved and thus a staged repair should be considered [6].

Gentle dilation is performed to allow introduction of the anoscope and complete examination of the anal canal is performed to evaluate for internal opening. This may be enhanced by injection of hydrogen peroxide or other dye into the external opening or by gentle introduction of a probe through the external opening. Care must be taken not to force a new tract or opening, thus creating a more complicated fistulous tract.

24.2.3.1 Fistulotomy

After gently passing a probe down the tract through the external opening (Fig. 24.4), an incision may be made on the probe using a scalpel or electrocautery through the perianal skin and rectal mucosa. The edges of the tract should be excised completely, and care should be taken not to undermine the edges (Fig. 24.5). In addition, continual assessment of any involved sphincter musculature should take place and division of obvious muscle should be avoided. Once open, the fistulous tract should be cleaned with a curette to remove any granulation tissue. Complicated tracts may require that an incision extend only as far as the probe can be safely passed; once the tract has been partially opened, it may be possible to determine the direction of the next portion of the tract and move the probe accordingly for guidance. At the completion of the procedure, light packing tape may be placed in the fistula tract, and an InStat (petroleum jelly on gauze) dressing placed in the rectum (Fig. 24.6).

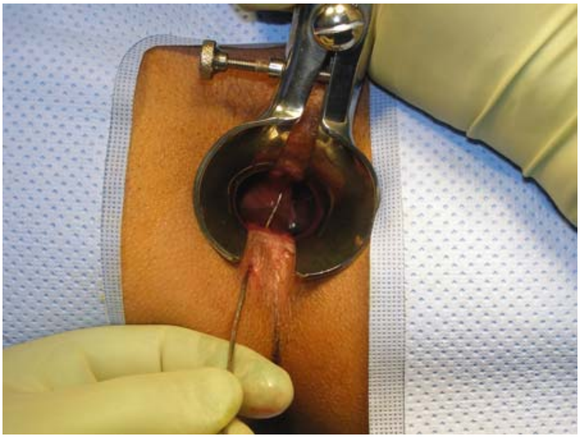

Fig. 24.4 Locating the fistulous tract. The probe is carefully inserted through the external opening, and allowed to follow the tract until it exits through the internal opening. This will serve as a guide for either subsequent fistulotomy or seton placement

Fig. 24.5 Fistulotomy. After carefully opening along the probe, granulation tissue at the base of the tract is removed with a curette. Note that the edges are clean and are not undermined

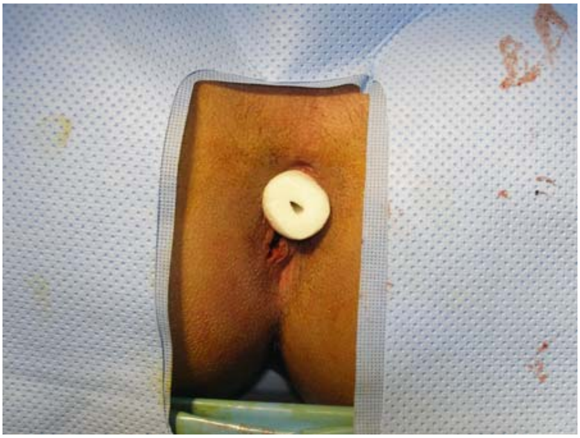

Fig. 24.6 InStat placement. At the end of the procedure, the perineum should be cleaned and an InStat dressing placed in the anal canal. Patients should be instructed to keep this light packing in place using a temporary mesh undergarment until it falls out with the first postoperative bowel movement

24.2.3.2 Seton Placement

As described above, the skin and mucosa overlying the fistulous tract should be opened with electrocautery or scalpel. When the sphincter musculature is encountered, the tract and openings should be cleaned with a curette and prepped for seton placement. Selection of type of seton is dependent on the goals of the operation:

1) *Cutting setons* will gradually cut through the sphincter muscle via pressure necrosis, with fibrosis behind the seton, preventing sphincter retraction and incontinence. A large Ethibond or other braided suture is placed through the internal and external openings of the fistulous tract and tied down onto the sphincter complex. The seton will then be "advanced" over the course of the next several weeks until the fistulous tract is completely incised. Advancement

of a cutting seton can be performed in the outpatient colon and rectal surgery clinic or in the operating room. However, care must be taken to not advance the seton too quickly, as the patient will experience a tremendous amount of pain as well as suffer a complication of sphincter division.

2) *Draining setons* will keep the fistulous tract open, allowing for abscess drainage and tract maturation, therefore facilitating a future fistulotomy or other advanced fistula closure technique. A vessel loop or large Ethibond suture is passed through the internal and external openings of the fistulous tract and tied loosely around the sphincter complex (Fig. 24.7). Other indications for use of a draining seton include: (1) complex anorectal fistula extensively involving the external sphincter, with the goal of staged fistulotomy; (2) complex anorectal fistula in the setting of sepsis; (3) anterior high transsphincteric fistula in a female patient; (4) high transsphincteric fistula in a patient with AIDS; (5) long-term fistula treatment in a patient with active IBD; and (6) concern for fistulotomy leading to fecal incontinence [5].

Repeat examination should be made in 6–8 weeks, with either fistulotomy or replacement of seton if still concerning for postoperative incontinence.

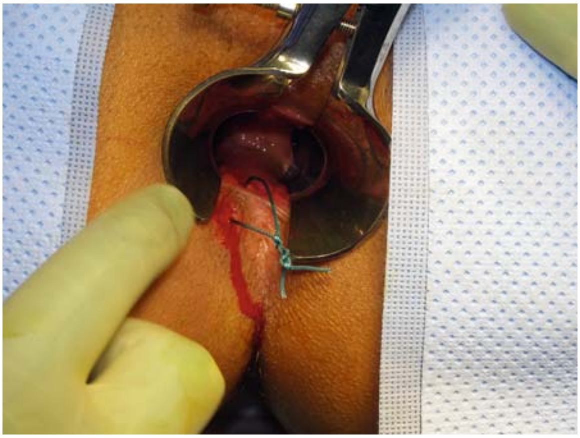

Fig. 24.7 Draining seton placement. The seton is placed through the external and internal fistula openings and tied loosely to maintain drainage. Here, a vessel loop is used, but Ethibond suture may be substituted

24.2.3.3 Endorectal Advancement Flap

For patients with complex anal fistula, particularly in locations threatening to produce incontinence with traditional measures, the endorectal advancement flap can provide definitive treatment by occluding the internal opening. This elimination of the drainage source thus allows the fistulous tract and external opening to close over time.

The patient is brought to the operating room and following induction of anesthesia, placed into either lithotomy or prone-jackknife position. The perineum is

prepped and draped in a sterile fashion. Digital rectal examination is performed to evaluate for mass, fissure, internal fistula opening, or other abnormalities. In addition, the depth of the fistulous tract relative to the external sphincter is confirmed. Granulation tissue is cleaned from the fistulous tract and the internal opening using a curette. A trapezoidal-shaped flap is elevated distal to the internal fistula opening using electrocautery, initially remaining in the submucosal plane, but transitioning to full-thickness as the flap is developed in the cephalad direction. Once adequately elevated with good hemostasis, the internal opening is closed in a transverse fashion using interrupted 4-0 chromic sutures. The area is cleaned with gentle irrigation. Finally, using gentle traction, the flap is advanced distally and sutured to the underlying mucosa using interrupted 2-0 Vicryl sutures, progressing from proximal to distal. Care should be taken to space the sutures sufficiently to achieve a tension-free repair. When the flap has been laid down and confirmed to extend beyond the internal opening, sutures may be placed in the anoderm as well. If needed, Bacitracin and Gelfoam may be applied with light pressure to achieve hemostasis at the completion of the flap procedure. Any open external portion should be dressed with wet-to-dry gauze dressing overnight. Alternatively, a deep cavity can be drained with a mushroom-tip catheter left in place for several days. The patient should be admitted for postoperative observation and pain management.

Healing time is estimated at 6 weeks. Incidence of recurrent fistula after endorectal advancement flap has been reported to be 3% in a series of 164 patients [7].

24.2.3.4 Alternative Surgical Approaches

Anal Fistula Plug

Patients who are not candidates for primary fistulotomy present a surgical challenge. The treatment of choice is not clear and is surgeon-dependent. Many surgeons prefer to proceed with an endorectal advancement flap, as described above. However, alternative approaches exist. The anal fistula plug may be employed in patients with fistulae, otherwise requiring seton placement. It is recommended by some authors as first-line treatment in simple fistulae, citing initial successful healing in 70.8% of patients, compared to 35% of those with complex fistulae. However, repeat plug placement may have diminishing returns and long-term success of this technique may approach 50–60% at one year [8].

Prior to fistula plug placement, the patient should have undergone an examination under anesthesia and had a draining seton placed. The seton allows the tract to mature and remain open. After approximately 6 weeks, the patient is brought back to the operating room for fistula plug placement.

The patient is positioned as described above and the perineum prepped and draped in a sterile fashion. Following digital rectal examination, the fistulous tract is identified and any granulation tissue at the internal or external openings is gently debrided with a curette. The anal fistula plug is then brought onto the field and reconstituted in saline. A fistula probe is passed through the opening and the fistula plug is secured to the probe to facilitate advancement. The plug is then carefully

pulled through the fistulous tract from the internal opening to the external opening, just flush with the opening and the internal sphincter. The internal portion of the plug is trimmed, and two figure-of-eight sutures are placed through the plug, submucosa, and sphincter to secure and cover the plug. The plug is secured to one side of the external opening of the tract using a single 3-0 Vicryl suture. Alternatively, an endorectal advancement flap may also be utilized to cover the internal opening with the plug in place. Bacitracin ointment is applied to the external portion and an InStat dressing left in the rectum.

Fibrin Glue

Fibrin glue may be used as an alternative means of occluding the fistulous tract. The patient is positioned as described and the perineum prepped and draped in a sterile fashion. Following digital rectal examination, the fistulous tract is identified and any granulation tissue at the internal or external openings is gently debrided with a curette. The internal opening is closed, either primarily or in combination with an endorectal advancement flap. Fibrin glue or other similar sealant is then gently injected through the external opening until the tract is full. An external dressing is applied and an InStat dressing left in the rectum.

Success of this technique is variable, with long-term healing reported at 31–60% [9–12]. However, it can be used to avoid a large operation in risky patients and has minimal associated morbidity.

24.2.4 Special Postoperative Considerations

Warm sitz baths may be used for comfort and fiber or other bulk-producing agents should be introduced the next day. Patients undergoing seton placement should be reminded that drainage will continue postoperatively and to return for evaluation if the drainage increases, changes in quality, or is accompanied by increased pain or fever.

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Chapter 25
Pilonidal Operations

Marie K. Stelzer and Gregory D. Kennedy

25.1 Indications

The incidence of pilonidal disease is approximately 0.7% in young adults and is commonly accepted to be an acquired condition caused by embedded hairs in the intergluteal cleft [1]. Pilonidal disease may present as an acute abscess, a simple pilonidal cyst, or a complicated or recurrent sinus. Primary midline openings or pits may be seen in the gluteal cleft approximately 5 cm cephalad to the anus [1]. Chronic sinus tracts become lined with squamous epithelium. Recurrence rates vary depending on the study and procedure (Table 25.1).

Table 25.1 Comparison of treatment methods for pilonidal disease [1]

Method	IP or OP treatment	Dressing changes required	Weeks to healing (average)	Recurrence (%)
Abscess drainage/shaving	OP	Yes	3–4	25–40
Excision	OP	No	3	16
Fistulotomy	OP	Yes	4–6	1–19
Marsupialization	OP	Yes	6	8
Wide local excision only	OP	Yes	8	Up to 38
Wide local excision, primary closure	OP	No	4–8	Up to 38
Excision, advancement flap	IP	No	3–4	6–20
Karydakis advancement flap	IP	No	3	1.3
Cleft closure	OP	No	3	3.3

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25.2 Perioperative Care

25.2.1 Preoperative Preparation

Acute infection should be resolved prior to definitive operation. Abscesses should be drained and cellulitis treated with antibiotics. Most patients are under the age of 40; therefore, minimal preoperative testing is required. Smoking cessation should be encouraged to assist wound healing.

25.2.2 Positioning and Anesthesia

After general anesthesia is induced, the patient is placed in the prone-jackknife position. Tape to spread the gluteus facilitates full visualization of the cleft. Hair is clipped in the affected area. Patients are administered intravenous antibiotics prior to surgical incision.

25.3 Description of the Procedures

Many operations have been described for the treatment of pilonidal disease. Few have been studied in a randomized controlled fashion. Therefore, recommendations on operative approach are difficult to make. However, we prefer to start with the simplest operation and advance our interventions to the more complex, as necessary. Below we describe the operative approaches employed at our institution.

25.3.1 Fistulotomy and Curettage

Sinus tracts are identified with probe and opened longitudinally using knife or Bovie cautery. The wound base is curetted. Wound heals by secondary intention. Patients must have BID postoperative wound care to facilitate healing. Alternatively, wound vacuum can be employed to assist in wound care and shorten length of healing.

25.3.2 Marsupialization

Sinus tracts are identified and typically excised but can be unroofed. The wound base is curetted and all hair removed. The defect that remains is often large and requires significant dressing changes. Therefore, the skin edges are sewn to the fibrotic wound base/presacral fascia using interrupted 3-0 Vicryl suture (Fig. 25.1) [2]. This decreases the size of the wound significantly and anecdotally shortens healing time. Figures 25.10– 25.14 demonstrate operative technique in a patient with recurrent pilonidal disease.

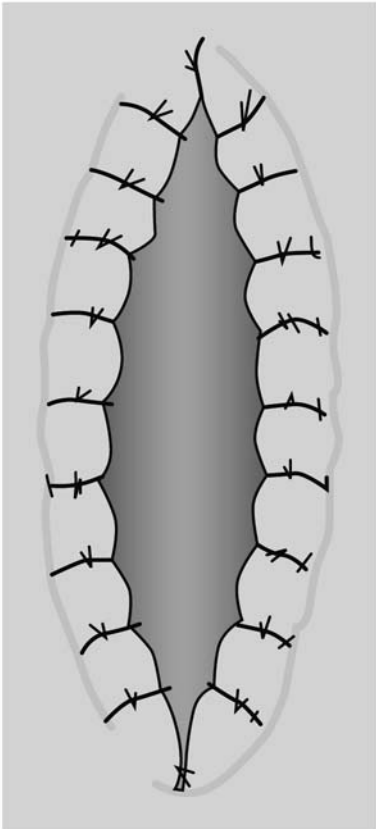


Fig. 25.1 Marsupialization

25.3.3 Excision and Primary Closure

This operation by definition requires excision of the entire sinus tract. Karydakis modified the operation so the sinus is excised elliptically and the wound is closed off the midline (Fig. 25.2). To accomplish this, a thick flap is created and advanced across the midline.

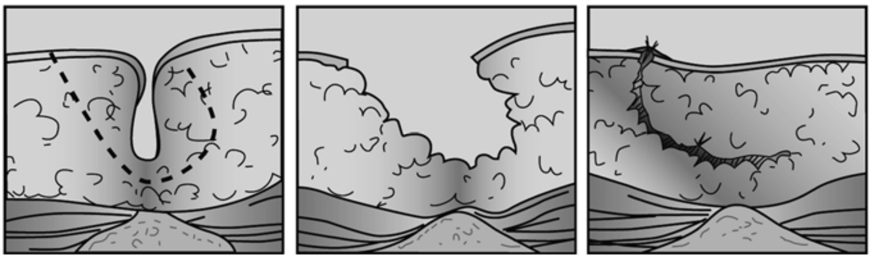


Fig. 25.2 Primary excision and closure

25.3.4 Cleft Closure

Full-thickness skin flaps are raised bilaterally (Fig. 25.3). The wound is debrided. Gluteal fat is apposed with absorbable sutures. Excess skin is removed and the wound is closed with 4-0 nylon interrupted suture.

Fig. 25.3 Cleft closure

25.3.5 Z-Plasty

The sinus tract is excised in the midline, which becomes the central limb of the Z (Fig. 25.4). For the classic Z-plasty, the limbs are incised at 60° angles to the central limb. The length gain of a Z-plasty varies based on the angle incised (Table 25.2). All limbs are of equal length. Subcutaneous skin flaps are created under A and B, then transposed as shown. The resulting central limb will be perpendicular to the original central limb. The skin is closed with 4-0 nylon interrupted suture.

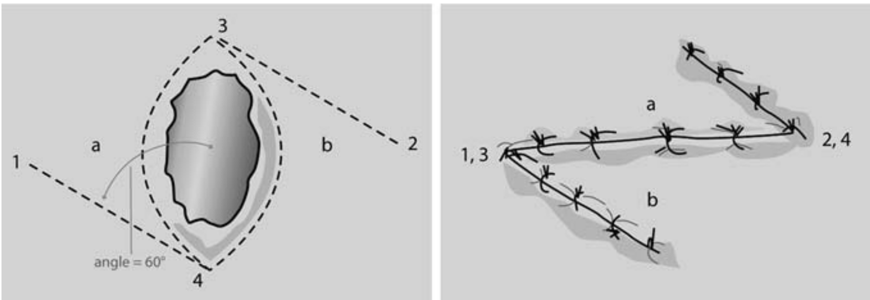


Fig. 25.4 Z-plasty

25.3.6 V-Y Advancement Flap

These flaps can be unilateral or bilateral (Fig. 25.5). A unilateral flap is capable of covering 8–10 cm defects while a bilateral flaps are needed to cover >10 cm defects [2]. The sinus tracts are excised in the midline and the base of the V points

Table 25.2 Length gain after Z-plasty [5]

Angles of Z-plasty (degrees)	Theoretical gain in length (%)
30–30	25
45–45	50
60–60	75
75–75	100
90–90	120

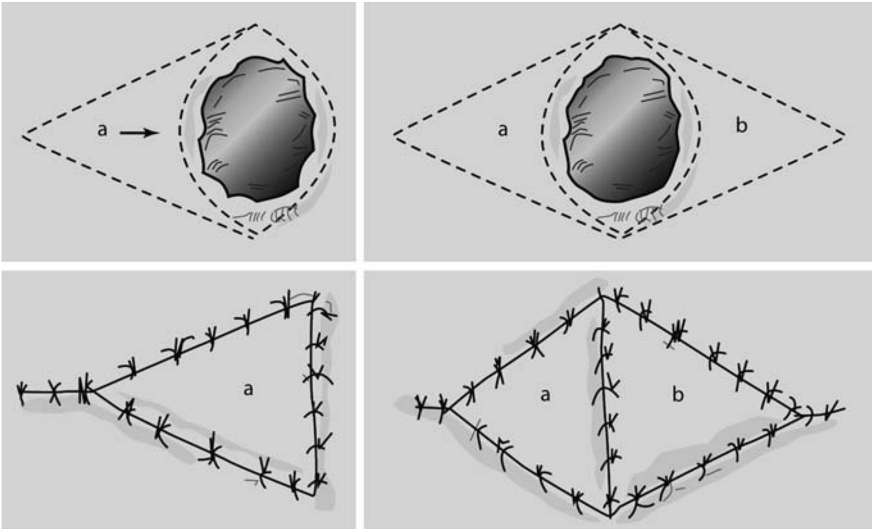


Fig. 25.5 V-Y advancement flap

laterally. The triangular flap is made 1.5–2× as long as the defect in the direction of the advancement and the base of the triangle equal to the perpendicular diameter of the defect [3]. The skin flap is undermined at the medial edge while fascia is undermined as little as necessary at the lateral edge (Fig. 25.6). Skin hooks are used to pull the leading edge of the flap to the far edge of the defect. The lateral aspect of the harvest site is reapproximated making the stem of a Y. The inferior and superior edges of the Y are closed with 3.0 Vicryl deep dermal interrupted sutures and 4-0 nylon interrupted sutures for skin.

25.3.7 Rhomboid Flap

The sinus tract is excised from the midline in the shape of a rhomboid. This flap depends on the looseness of the adjacent tissue. The rhomboid has two opposite

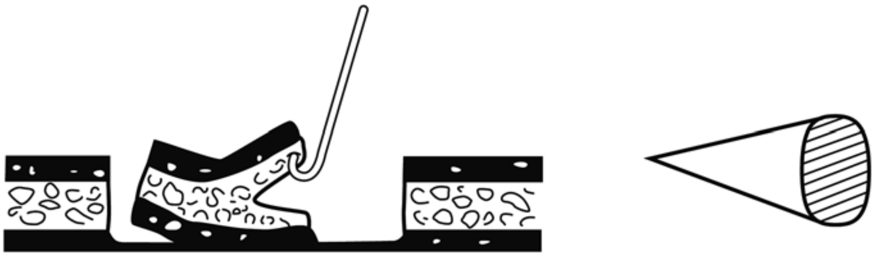
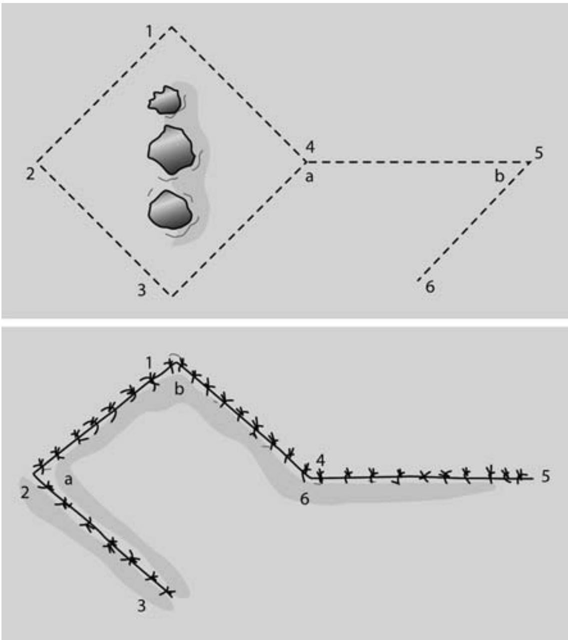


Fig. 25.6 V-Y advancement flap cross sectional view

Fig. 25.7 Rhomboid flap



60° angles and two opposite 120° angles. Each side of the rhomboid is equal to the short axis 2–4. This axis is extended by its own length to point 5. The 3–4 lines and 6–5 lines are parallel. A flap is created down to the muscular fascia and rotated as shown (Fig. 25.7). The flap is secured with 4-0 nylon interrupted suture. Four flaps are available for any rhomboid defect (Fig. 25.8).

25.3.8 Gluteus Maximus Myocutaneous Flap

This rotational flap is capable of covering large defects (Fig. 25.9). To avoid functional deficits, only one half of the muscle is used. For pilonidal disease, the superior

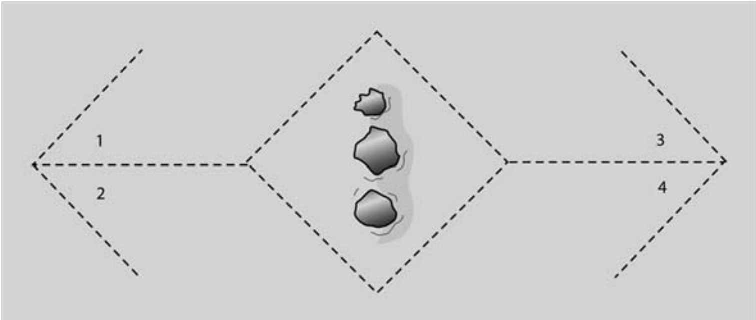


Fig. 25.8 Rhomboid flaps available for a defect

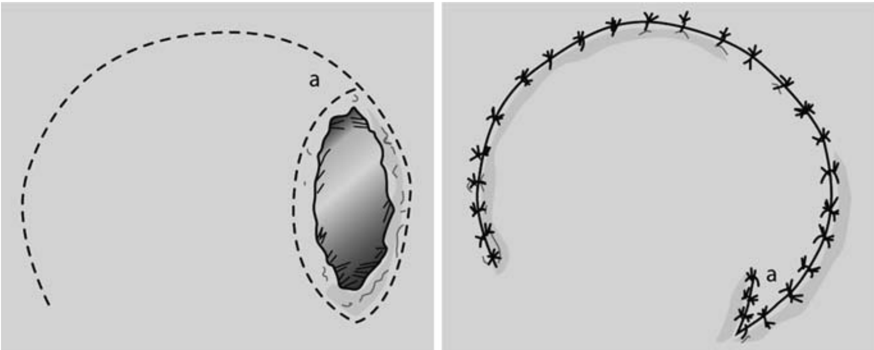


Fig. 25.9 Gluteus maximus myocutaneous flap

aspect of the gluteus muscle is typically used to create a flap. The superior gluteal muscle vessels exit above the piriformis muscle and just lateral to the sacrum. The sciatic nerve exits below the piriformis muscle, as do the inferior gluteal vessels and they should be avoided. The defect is excised down to presacral fascia removing all prior scar tissue. A circular flap is created and the upper portion of the gluteus maximus is transected down to the gluteus medius and piriformis muscles [4]. The base of the flap should be 4–5 times the length of the defect [5]. After flap rotation, a suction drain is placed. The wound is closed in layers and skin edges are secured with 4-0 nylon interrupted suture. The patient should not lie flat for several days.

Fig. 25.10 Preoperative positioning in this patient with recurrent pilonidal disease

Fig. 25.11 Identification of sinus tract with probe

Fig. 25.12 Debridement to the sacral fascia

Fig. 25.13 Marsupialization with interrupted suture

Fig. 25.14 Completed marsupialisation

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Chapter 26
Hemorrhoids

Carter T. Smith and Gregory D. Kennedy

26.1 Indications

Hemorrhoids are mucosal vascular cushions in the anal canal, which are present in all individuals. They aid in closure of the anal canal at rest and help prevent incontinence to stool and flatus. They are classically located in the left, right posterior, and right anterior positions (from the patient perspective). Only when these cushions of tissue become symptomatic do they become what the general public refers to as "hemorrhoids." Hemorrhoidal disease is common with 1 million new cases a year and prevalence in the United Sates of 8.5 million people. These cases account for 1.9 million ambulatory visits and 168,000 hospitalizations a year [1].

Prolapse, bleeding, thrombosis, pain, itching, and difficulty with hygiene are all chief complaints of symptomatic hemorrhoids [2]. Of these painless bleeding is the most common complaint [3]. Hemorrhoids may be external or internal to the dentate line. Internal hemorrhoids are classified by degree of prolapse. First-degree hemorrhoids are characterized by zero prolapses while fourth-degree hemorrhoids are incarcerated (Table 26.1). Figure 26.1 shows an example of third-degree hemorrhoids.

Hemorrhoids may occasionally present in an emergent situation. Acutely thrombosed external hemorrhoids are exquisitely painful and present as a hard prolapsed hemorrhoid with surrounding erythema. Simple evacuation results in a high rate of future symptoms and these patients are best treated by excision of the thrombosed hemorrhoid. Thrombosis of internal hemorrhoids is less common and may not require surgical intervention, but excisional hemorrhoidectomy is called for if surgical treatment is necessary [3]. Additionally, strangulated hemorrhoids are not only thrombosed, but infarcted and infected. Closed hemorrhoidectomy may cause sepsis in these patients and open hemorrhoidectomy should be pursued [4].

The treatment of hemorrhoids is centered on relief of symptoms. Operations to improve appearance of the anus may lead to complications that are worse than

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Table 26.1 Classification of hemorrhoids and their typical symptoms

	First degree	Second degree	Third degree	Fourth degree
Findings	Bulge into the lumen of the anal canal ± painless bleeding	Protrude at the time of a bowel movement and reduce spontaneously	Protrude spontaneously or with bowel movement, require manual reduction	Permanently prolapsed and irreducible
Symptoms	■ Painless bleeding	■Painless bleeding ■ Anal mass with defecation ■Anal burning or pruritus	■Painless bleeding ■Anal mass with defecation ■Feeling of incomplete evacuation ■Mucous leakage ■Fecal leakage ■Perianal burning or pruritus ani ■Difficulty with perianal hygiene	Painless or painful bleeding ■Irreducible anal mass ■Feeling of incomplete evacuation ■Mucous leakage ■Fecal leakage ■Perianal burning or pruritus ani ■Difficulty with perianal hygiene
Signs	■Bright red bleeding ■Bleeding at the end of defecation ■Blood drips or squirts into toilet ■Bleeding may be occult	■Bright red bleeding ■Prolapse with defecation	■Bright red bleeding ■Blood drips or squirts into toilet ■Prolapsed hemorrhoids reduce manually ■Perianal stool or mucous ■Anemia extremely rare	■Bright red bleeding ■Blood drips or squirts into toilet ■Prolapsed hemorrhoids always out ■Perianal stool or mucous ■Anemia extremely rare

Fig. 26.1 Third-degree hemorrhoids. This patient has been placed in high lithotomy position for examination and treatment

the initial presentation such as incontinence, fistula formation, or anal stenosis. Many symptomatic hemorrhoids are managed successfully by medical therapy. This includes dietary fiber supplements, stool softeners, increased fluid intake, and avoidance of straining. It is important to perform an adequate physical exam prior to surgical therapy to evaluate for the presence of a fissure, fistula, or anal or rectal masses. Treatment of these problems will affect treatment of hemorrhoids if they are also present [2].

26.2 Perioperative Care

26.2.1 Preoperative Preparation

Patients may undergo hemorrhoidal operations in the outpatient clinic, day surgery suite, or inpatient operating room. The preoperative care will vary slightly, but will generally have the same components. Full medical evaluation should be performed to ensure safety of anesthesia. A preoperative bowel prep is usually prescribed and may range from an enema or suppository to evacuate the rectum to a more complete prep with one or two doses of magnesium citrate followed by enemas the evening prior to and morning of the operation. All patients undergoing procedures in the operating room should not eat of drink anything after midnight. Antibiotics are administered prior to incision and should generally be targeted toward the normal colonic flora.

26.2.2 Positioning and Anesthesia

The patient may be placed in the lateral decubitus, jackknife, or high lithotomy position. Office procedures under local anesthetics are best served by the decubitus or jackknife approach, while either jackknife or high lithotomy may be used in the operating room. In the jackknife position care needs to be taken to avoid pressure on facial structures. In high lithotomy the patient's heels are placed in stirrups of some type. Care should be taken to avoid pressure on the heels and calves. Choice of anesthesia involves extent of the planned procedure, patient anxiety and pain, likelihood of additional pathology, anesthetic risk, and patient preference. Local anesthesia alone may be used for simple procedures, but conscious sedation, spinal anesthesia, or general anesthesia with laryngeal mask or endotracheal tube may be needed for more complicated hemorrhoid treatment. In general, deep anesthesia is preferred when performing operations in the anal canal. This prevents the patient from straining against the anal speculum and traumatizing the sphincter mechanism. Preparation of the anus and perianal region should be performed with a full Betadine scrub.

26.3 Description of the Procedure

26.3.1 Sclerosis

Injection of a sclerosing agent may be used to treat first-, second-, and third-degree hemorrhoids. One to 5 ml of sclerosing agent (ethanoleum oleate, sodium morrhuate, or quinine urea) is injected into the submucosa of each hemorrhoid. The resultant ulceration and scarring prevent prolapse. Care should be taken in the anterior direction to inject superficially. The prostate or periprostatic venous plexus may be injured with deep injection [2, 4].

26.3.2 Infrared Photocoagulation

The tip of the instrument is placed above each hemorrhoid and infrared radiation coagulates the underlying plexus. This treatment is only suited for first and minor second-degree hemorrhoids [2, 4].

26.3.3 Rubber-Band Ligation

Rubber-band ligation is best suited for first, second, and few third-degree hemorrhoids. This technique involves the application of a rubber band to the mucosa above the hemorrhoidal tissue and 1–2 cm above the dentate line. This causes necrosis of the captured tissue, ulceration, and scarring, which prevents prolapse or bleeding. A slotted anoscope or anal speculum is inserted and the hemorrhoidal tissue is allowed to protrude into the slot. Rubber bands may be applied by a suction or non-suction device. The mucosa just above the hemorrhoidal cushion is either grasped with a clamp or suctioned into the tip of the banding device. The pre-loaded band is then deployed by squeezing the trigger on the device. Care should be taken to ensure the band is employed above the dentate line to ensure no sensate mucosa is included. Immediate and postoperative pain are indications of inclusion of this mucosa and removal of the bands may be necessary [2, 4].

The goal of rubber-band ligation is to include the feeding vessel of the hemorrhoid within the band. This should be kept in mind when applying the rubber band and tissue considered for ligation should be well above the level of the dentate line. Outcomes of the three office-based procedures, sclerosis, infrared photocoagulation, and rubber-band ligation are similar, although infrared photocoagulation shows less postoperative pain [5]. However, potential complications and longevity of the procedures is somewhat varied. If applied correctly, rubber-band ligation has a lower complication rate, is better tolerated, and has a higher chance of long-term success [5]. For that reason, we generally feel that rubber-band ligation should be used preferentially over the alternative non-excisional therapies.

26.3.4 Hemorrhoidectomy

26.3.4.1 Open Hemorrhoidectomy

Open hemorrhoidectomy is also known as the Milligan and Morgan hemorrhoidectomy. The hemorrhoidal tissue is visualized with a slotted anoscope or speculum (See Fig. 26.2). Injection of a local anesthetic with epinephrine will aid in immediate postoperative pain as well as operative bleeding. An elliptical incision is started proximal to the anal verge and carried across the dentate line to the anorectal ring. The vital step is to separate the fibers of the internal sphincter from the hemorrhoidal tissue. Metzenbaum scissors may be used to spread parallel and superficial to the fibers to separate them from the mucosal tissue dissecting in a distal-to-proximal fashion (See Fig. 26.3). At the proximal corner the pedicle of the hemorrhoid is suture ligated with non-absorbable suture. Electrocautery is used to achieve hemostasis along the bed. The pedicle is then transected and the hemorrhoidal tissue removed. A gauze dressing is applied and the wound is left open to heal by secondary intent [2, 4].

Fig. 26.2 Combined internal–external hemorrhoid. A slotted anoscope is positioned to allow excision of the hemorrhoid

26.3.4.2 Closed Hemorrhoidectomy

The Parks or Ferguson hemorrhoidectomy involves the same initial steps as the open operation except the wound is closed with suturing. The hemorrhoid is dissected out the same way, again with care to identify and separate the fibers of the internal

Fig. 26.3 Hemorrhoidectomy. Dissection is carried proximally under the hemorrhoidal tissue taking care to separate the fibers of the internal sphincter with Metzenbaum scissor

sphincter. The pedicle is suture ligated or encompassed in the anchoring stitch of the closing suture. The mucosa is then closed using a locking stitch to the dentate line and then a running stitch. A gauze dressing is then applied. We use an absorbable hemostatic dressing (Instat, Ethicon Inc.), rolled and inserted into the anus with Russian forceps [2, 4].

26.3.4.3 LigaSure and Harmonic Scalpel Hemorrhoidectomy

These are both relatively new additions to operative procedures for hemorrhoids. A recent meta-analysis of LigaSure versus conventional hemorrhoidectomy showed a decrease in operative time and bleeding and increase in operative cost with the LigaSure device [6]. A randomized trial of closed hemorrhoidectomy versus harmonic scalpel showed no difference in outcomes [7]. Another randomized trial compared Harmonic scalpel hemorrhoidectomy, bipolar scissors hemorrhoidectomy, and scissors excision and found decreased bleeding with both Harmonic scalpel and bipolar scissors and pain was less with the Harmonic scalpel [8]. The answer is still unclear and further research is needed.

26.3.4.4 Stapled Hemorrhoidopexy

This technique involves removing a circumferential portion of rectal mucosa proximal to the dentate line. The goal is to ligate venules feeding the hemorrhoidal

plexus and reduce redundant mucosa. This technique is based on the Whitehead's hemorrhoidectomy, which involved excision of this ring of tissue and manual approximation of the anal mucosa to the dentate line. Whitehead's procedure carries a risk of ectropion or prolapsing rectal mucosa, known as Whitehead's deformity [2]. The stapled procedure involves placing an operating anoscope for visualization. A purse-string suture is then placed around the rectal mucosa 4–5 cm proximal to the dentate line. The stapler is inserted in the anus with the anvil extended. The purse string allows the surgeon to draw the mucosa into the device as the stapler is fired. This excises the ring of tissue and approximates the remaining edges with staples. A systematic review of stapled hemorrhoid treatment found reduced early postoperative pain but increased risk of residual prolapse with the staple device [9]. However, long-term followup comparing recurrence rates of Morgan-Milligan hemorrhoidectomy to stapled hemorrhoidopexy demonstrated no increase in risk for early recurrence of hemorrhoidal prolapse [10].

The role of stapled hemorrhoidopexy remains unclear but it is in widespread use. Prior to its application, a thorough discussion of uncertainties with the procedure should occur. Patients should clearly understand the goal of the operation as being to excise the redundant internal tissue that allows the internal hemorrhoids to prolapse. They should be advised of and willing to accept unclear rates of long-term recurrence. Additionally, patients with a large external component to their hemorrhoidal disease may not be good candidates, as the stapled hemorrhoidopexy will not address this problem.

26.4 Special Postoperative Considerations

Postoperative pain is common following any excision operation for hemorrhoids. Narcotic pain relievers are usually needed for adequate pain control. Sitz baths, muscle relaxers, NSAIDs, and topical analgesics may also help. Stool softeners and laxatives can reduce pain with defecation and lower the risk of fecal impaction as a result. Complications also include urinary retention, reactionary hemorrhage, secondary hemorrhage, fissure or fistula, anal stenosis, incontinence for flatus or stool, perirectal abscess, necrotizing soft tissue infection, and anorectal sepsis. Secondary hemorrhage following rubber-band ligation approximately 7–10 days is common and usually self-limited [2, 4].

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Part VII
Hernia Surgery

Section Editor: David M. Melnick

Chapter 27
Abdominal Wall Hernias: Introduction

David M. Melnick and Jacquelynn D. Arbuckle

27.1 Indications

Surgeons have recently re-evaluated the indications for operating on groin hernias. Elective surgery is indicated for symptomatic hernias causing pain, a large bulge, or intermittent incarceration. A recent study partially funded by the American College of Surgeons randomized 720 men with asymptomatic hernias to either operation or nonoperative management and found no difference in the complication rate relating to acute herniation between the two groups [1]. Regarding incisional ventral hernias and umbilical hernias, operation is generally indicated for symptomatic hernias, with relative contraindications including comorbidities and obesity. Cirrhosis with ascites is not a contraindication for repair of umbilical hernias and operation may lead to fewer complications than observation [2].

27.2 Preoperative Preparation

The surgeon should perform a standard history and physical, with appropriate evaluation for preoperative medical comorbidities such as heart disease, diabetes, and lung disease, with appropriate preoperative medical management. Antibiotics should be used in more complicated cases of inguinal hernia repair, including significant medical comorbidities or the possibility of a more complicated procedure, but need not be used for routine, uncomplicated repairs, even with the use of mesh [3, 4]. Preoperative antibiotics should be utilized in more complicated ventral hernia repairs to prevent surgical site infections.

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27.3 Choice of Mesh

Inguinal hernia operations, including all laparoscopic and most open operations, involve the placement of a material to cover the hernial defect. In some cases, primary repair is appropriate as well. Mesh materials will be briefly summarized here.

Absorbable mesh. This mesh is typically used in contaminated wounds. If absorbable mesh is used to bridge a defect, hernia recurrence is likely. If absorbable mesh is used to support a primary repair, recurrence is less likely.
Biologic absorbable mesh. Acellular dermal matrix derived from donated human skin (AlloDerm, LifeCell Corporation), freeze dried soft tissue graft (Surgisis, Cook Biotech Incorporated.)

Synthetic absorbable mesh. Polyglactin 910 (Vicryl, Ethicon, Inc.)
Permanent mesh. This mesh should not be used in infected wounds, as the likelihood of mesh infection is high. In clean wounds, however, mesh offers the advantage of a tension-free repair and lower recurrence rates compared to primary repairs. Permanent meshes include polypropylene, polyester, and expanded PTFE.

Newer polypropylene meshes have a lighter weight and large pore size, to potentially reduce inflammation and possibly decrease the incidence of groin pain relating to hernia repair. Many synthetic permanent meshes have a layer of absorbable coating on one side. The coating can be placed on the intraperitoneal side of the mesh to prevent adhesions of bowel to the mesh, as the peritoneum grows over the mesh, prior to the absorbing of the coating.

Meshes with absorbable coatings include polypropylene meshes with a sodium hyaluronate-based bioresorbable membrane (Sepramesh, Genzyme Corporation), polypropylene with an oxidized regenerated cellulose coating (Proceed, Ethicon, Inc.), and polypropylene with an omega 3 fatty acid bio-absorbable coating (C-Qur, Atrium Medical Corporation). Also, some meshes have different properties on each side. Gore Dual Mesh (W. L. Gore and Associates) made from ePTFE, has a smooth side, designed to be placed against the viscera to prevent adhesions and a rough side designed to be placed against the abdominal wall where tissue ingrowth will occur.

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Chapter 28
Inguinal Herniorrhaphy

David M. Melnick and Jacquelynn D. Arbuckle

28.1 Positioning and Anesthesia

For a patient undergoing inguinal hernia repair, preoperative voiding to decompress the bladder is essential. In elderly male patients or others in whom there is a concern for prostatic hypertrophy and bladder outlet obstruction, urinary catheterization may be performed. For open repairs, either monitored anesthesia combined with local anesthesia, spinal anesthesia, or general anesthesia may be used with good results. A general anesthetic is necessary for laparoscopic cases. For open operations, the arms may be placed abducted laterally, while in laparoscopic cases, the arms can be tucked. The hair including pubic hair around the operative site should be clipped immediately preoperatively and standard skin preparation with an antibiotic solution such as povidone iodine or chlorhexidine should be used.

28.2 Description of the Procedure

Many techniques of hernia repair exist. The surgeon can primarily close the defect utilizing the Bassini repair, the McVey (Cooper's ligament) repair, or the Shouldice repair, among others. The surgeon can perform an open tension-free repair utilizing the Lichtenstein repair, the mesh plug repair (Bard PerFix Plug, Davol Inc.), and the Ethicon Prolene Hernia System preperitoneal underlay and overlay repair (Ethicon, Inc.). Finally, several laparoscopic techniques exist including the totally extraperitoneal preperitoneal (TEPP) and transabdominal preperitoneal (TAPP) techniques, with different companies offering unique versions of laparoscopic systems and customized mesh products. While in many cases the abundance of operations suggests less than optimal results, the modern methods of hernia repair all have shown excellent results. The Lichtenstein and TEP repairs will be described.

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28.3 Lichtenstein Tension-Free Repair of Inguinal Hernia

Obtaining exposure. After the patient is prepped and draped, draw a line from the anterior superior iliac spine to the pubic tubercle, delineating the course of the inguinal ligament. Use generous amounts of local anesthesia, then incise the skin 1–2 cm superior to this line, starting just lateral to the pubic tubercle and extending approximately 5–6 cm. Dissect through the subcutaneous fat, then through the fatty later of Scarpa's fascia. You will come to the areolar layer just superficial to the external oblique aponeurosis. Dissect this tissue off the aponeurosis to completely expose this layer, including the inferior edge of the aponeurosis. Follow the inferior edge medially to come to the pubic tubercle. Identify and palpate the external ring. You may find the ilioinguinal nerve exiting the ring. Infiltrate the subfascial tissues with the local anesthetic. Incise the external oblique aponeurosis with a scalpel and then use a scissors to open up this layer in the direction of its fibers, medially to open up the external ring, then laterally. Take care to avoid injuring the ilioinguinal nerve, which lies just beneath this aponeurosis (Fig. 28.1). Using a hemostat, grasp the inferior edge of the external oblique aponeurosis and lift it up. Use a "peanut" or "Kittner" to sweep the cord adhesions off the aponeurosis to expose the shelving edge of the inguinal ligament. You may also start dissecting behind the cord at this time. You can find the spermatic vessels and the genital branch of the genitofemoral nerve during this dissection. Use a second hemostat to grasp the superior edge of the external oblique aponeurosis, lifting it up. In a similar manner, sweep the cord structures off this structure to expose the conjoined tendon or conjoined area, lying deep to the aponeurosis. The conjoined area is seen as the fibrous white aponeurotic layer of the internal oblique aponeurosis (Fig. 28.2). The iliohypogastric nerve may

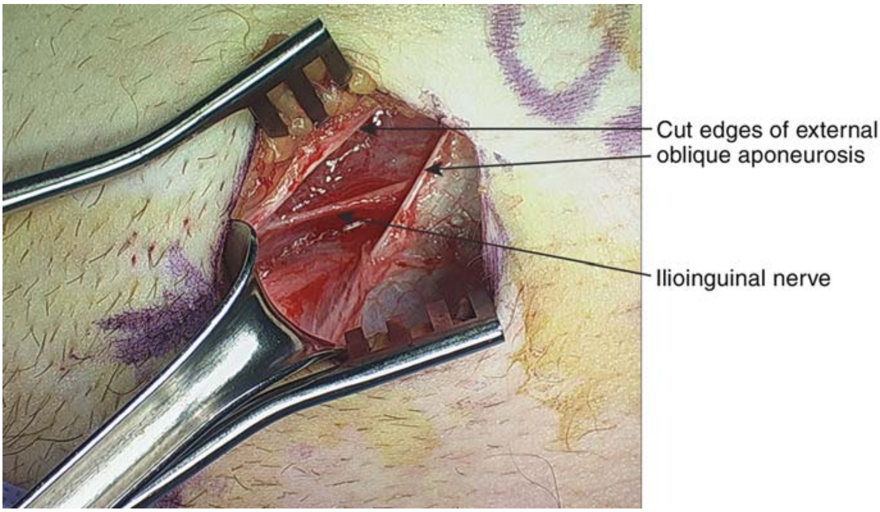

Fig. 28.1 Exposure for open repair of left inguinal hernia

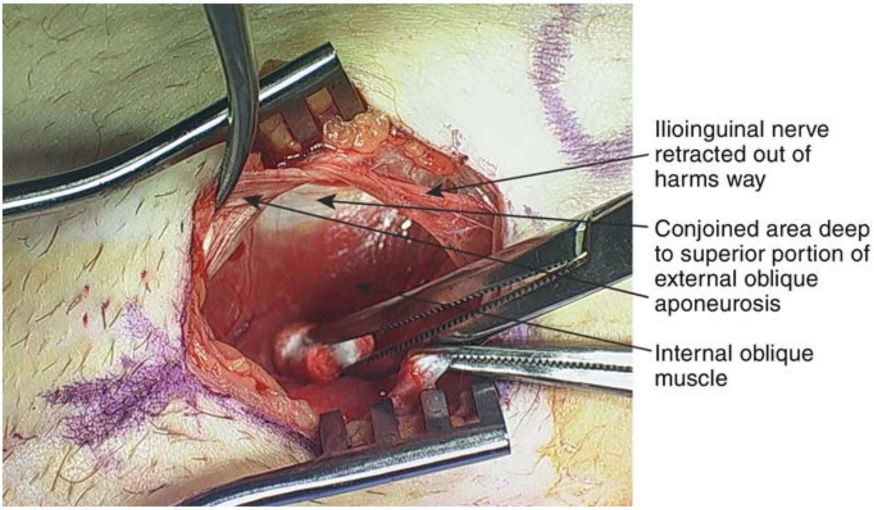

Fig. 28.2 Exposure of conjoined area

be seen in this area. For the repair, mesh will be sutured to the conjoined area as well as the shelving edge of the inguinal ligament [1, 2].

Dissect around the spermatic cord and secure the cord with a Penrose drain. Palpate the vas deferens within the cord. The vas feels like a piece of *al dente* spaghetti. This ensures that you have correctly isolated the spermatic cord. Identify the ilioinguinal and iliohypogastric nerves and retract each out of harms way by positioning them on the outside of the hemostats attached to the external oblique aponeurosis. Incise the cremasteric muscle fibers longitudinally to expose the spermatic cord. An indirect hernia will be seen on the anterior surface of the cord. A lipoma, a piece of preperitoneal fat protruding through the internal ring may also be found. If found, it should either be reduced through the ring or more likely, excised. If an indirect hernia is found, dissect the sac off the cord structures all the way back to the internal ring (Fig. 28.3). The sac may be incised and explored. If the sac is opened, place your index finger in the hole, palpate for the femoral artery, then palpate medially to search for a femoral hernia. You can then perform a high ligation of the sac and reduce the stump through the internal ring. Alternatively, the sac may be reduced without opening it. A direct hernia would be seen as an attenuation and bulging of the transversalis fascia in the medial aspect of the inguinal area, in Hesselbach's triangle; bordered by the inguinal ligament, the rectus muscle, and the inferior epigastric vessels.

Repair the hernial defect. A Bassini-type primary repair is done by approximating the conjoined area with the inguinal ligament using interrupted permanent sutures, such as 0-0 polyester sutures. The Lichtenstein repair performs the same basic anatomic repair, but uses mesh to bridge the gap to prevent the tension seen in primary repairs.

Fig. 28.3 Dissection of hernial sac off spermatic cord

Fashion a piece of 3–4 in. by 6 in. mesh. Expose the pubic tubercle by using one retractor to pull the spermatic cord superiorly and another to pull the inferior edge of the external oblique aponeurosis inferiorly. Palpate the pubic tubercle. Approximate the mesh using 0-0 polypropylene sutures to the aponeurotic tissues approximately 2 cm medial to the pubic tubercle. Then using that stitch as a continuous suture, approximate the inferior edge of the mesh to the shelving edge of the inguinal ligament to a point lateral to the internal ring, and then tie the stitch. Cut a longitudinal slit laterally in the mesh from the lateral edge to a point around the internal ring. Pass the superior tail of the mesh underneath the cord and tuck both tails laterally under the external oblique aponeurosis. Reposition the retractors so the spermatic cord is pulled inferiorly and the superior edge of the external oblique aponeurosis is pulled superiorly to expose the conjoined area. Using a simple interrupted 0-0 polypropylene suture, approximate the medial portion of the superior tail of the mesh with the tissue around the pubic tubercle, close to the original stitch, to prevent a medial hernia recurrence. Then using interrupted sutures, approximate the superior tail of the mesh with the internal oblique aponeurosis and stop lateral to the internal ring.

To close the new internal ring, approximate the inferior edge of the superior tail of the mesh with the inferior edge of the inferior tail of the mesh and also to the shelving edge of the inguinal ligament. Alternatively, many surgeons approximate the two tails of the mesh with each other, but not to the inguinal ligament. The new internal ring should be just large enough to admit the tip of a finger. Adjust the size accordingly. Examine the quality of the repair (Fig. 28.4).

Close the wound. Replace the nerves in the correct anatomic position overlying the mesh and ensure that no nerve injury or entrapment has occurred. If an injury or entrapment may have occurred, then divide the nerve laterally and excise

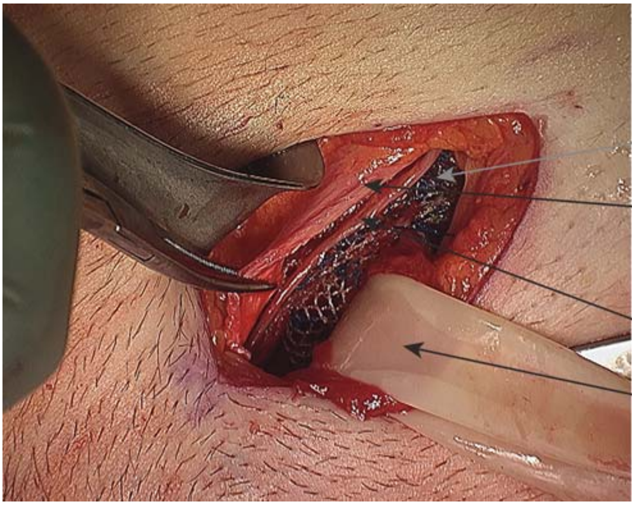

Fig. 28.4 Appearance of mesh and ilioinguinal nerve after repair

the exposed portion to prevent pain relating to a nerve injury. Reapproximate the external oblique aponeurosis using a continuous absorbable suture. Reapproximate Scarpa's fascia using a few interrupted absorbable sutures. Close the skin.

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Chapter 29
Totally Extraperitoneal Preperitoneal Laparoscopic Inguinal Hernia Repair

David M. Melnick and Jacquelynn D. Arbuckle

Whether you expose the preperitoneal space using the totally extraperitoneal preperitoneal (TEPP) method or the transabdominal preperitoneal (TAPP) approach, once the surgeon gains good exposure, the anatomy is the same. A single monitor is placed at the patient's feet.

Gain entry to the preperitoneal space. To get to the space via the TEPP technique, make a 10 mm incision just inferior to the umbilicus in the midline or just to the right side of midline. Dissect through the subcutaneous fat to expose the anterior rectus sheath. Curved S retractors are helpful in bluntly dissecting down to the anterior sheath. Make a 10 mm transverse incision in the sheath to expose the rectus abdominus muscle. Retract the medial edge of the muscle laterally to expose the posterior sheath. Bluntly dissect behind the muscle to open up this space. Inferior to the arcuate line, this space becomes the retroperitoneal space. Insert the balloon dissector into this space and inflate the balloon according to the manufacturer's recommendations. Do this slowly to prevent tearing of the many small retroperitoneal vessels. Remove the balloon dissector and place the 10-mm port and the 10-mm scope. Place the table in Trendelenburg position and observe the anatomy. Looking up, you should see the rectus muscles and epigastric vessels. Identify and palpate with the scope the pubic symphysis. Place two 5 mm midline ports, one just above the pubic symphysis and one halfway between that port and the 10-mm port. Position yourself on the contralateral side of the hernia and use two atraumatic graspers or other dissecting instruments.

Expose the anatomy and reduce the hernia. Identify and palpate the pubic symphysis with your instruments, then palpate Cooper's ligament. Dissect the adhesions off of the ligament to expose the white ligament, taking care to avoid injury to veins such as the obturator vein, which may overlie this structure. This marks the medial extent of the dissection, as no hernias can occur medial to this. Next, dissect the peritoneum off of the abdominal wall laterally, up to the arcuate line. You should

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be left with the hernial sac extending to the ring. With one grasper, secure the hernia sac and with the other dissect the cord structures and adhesions off of the sac. Pull the sac out of the internal ring until you can see the end of it, and then dissect the adhesions off of the end of the sac. Dissect the sac completely off the cord structures well away from them, up towards the umbilicus. Avoid dissecting in the "Triangle of Doom," the area deep to the spermatic cord where the femoral vessels lie, to avoid serious bleeding. Inspect the abdominal wall for a direct hernia as well as a femoral hernia, reducing those, if appropriate (Figs. 29.1 and 29.2). If the sac is densely adherent deep in the scrotum, you can divide the sac, leaving the portion in the scrotum open to drain into the preperitoneal space.

Repair hernial defect. Fashion a piece of mesh (typically polypropylene or polyester) to a size of approximately 10 × 15 cm. Fold the mesh in half the long way, introduce the mesh through the 10-mm port and unroll it. Position it transversely over the inguinal area, so the inferomedial aspect of the mesh is inferior and medial to Cooper's ligament, the superior medial aspect of the mesh is well above the hernial defect on the anterior abdominal wall, and the mesh is nicely positioned laterally (Fig. 29.3). Many surgeons use tacks to secure the mesh, one tack to Cooper's ligament, one to secure the superomedial mesh to the anterior abdominal wall, and one to secure the superolateral mesh to the anterior abdominal wall. Never put tacks inferior to the inguinal ligament laterally, in the so-called "Triangle of Pain," where the genitofemoral nerve lies. This can cause chronic postoperative pain. Randomized controlled trials have reported that the use of tacks, while associated with increased pain, does not reduce the risk of recurrence [1]. Newer bio-absorbable tacks have entered the market, with the hope that they will contribute to improved pain control among patients who undergo repairs with tacks. Inspect the quality of the repair.

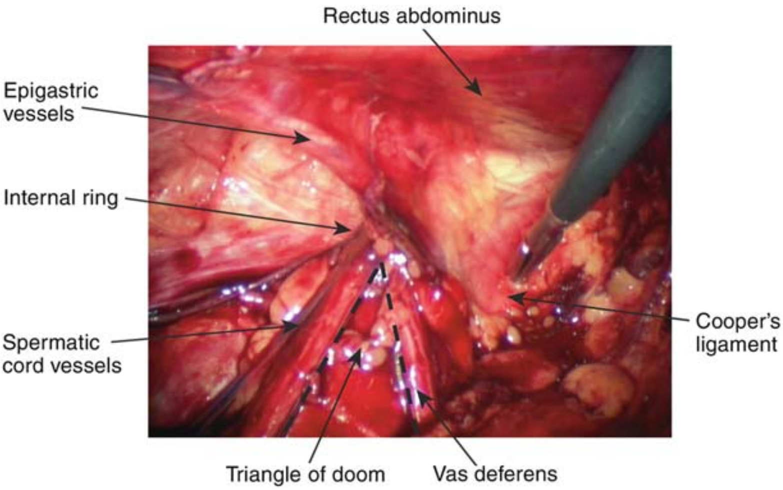

Fig. 29.1 Anatomy of left inguinal area with TEPP

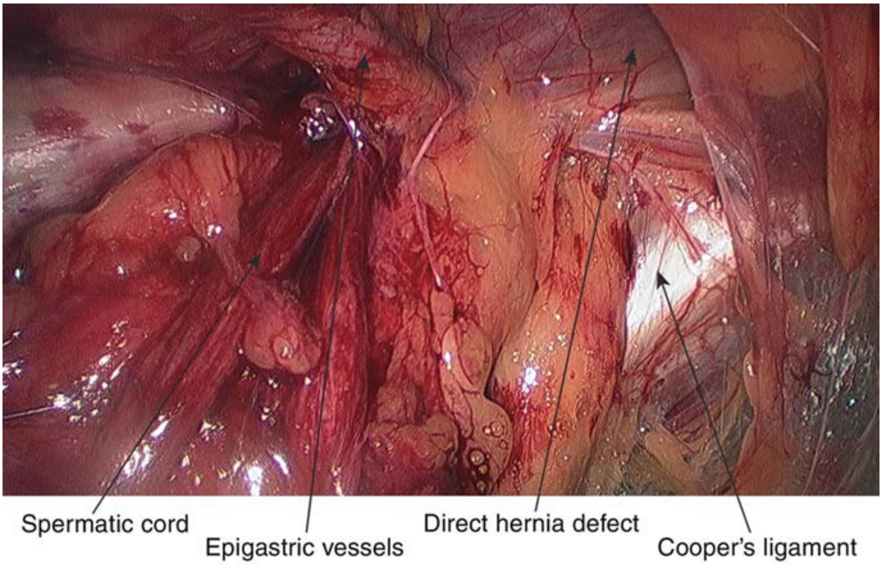

Fig. 29.2 Anatomy of left direct inguinal hernia, TEPP exposure

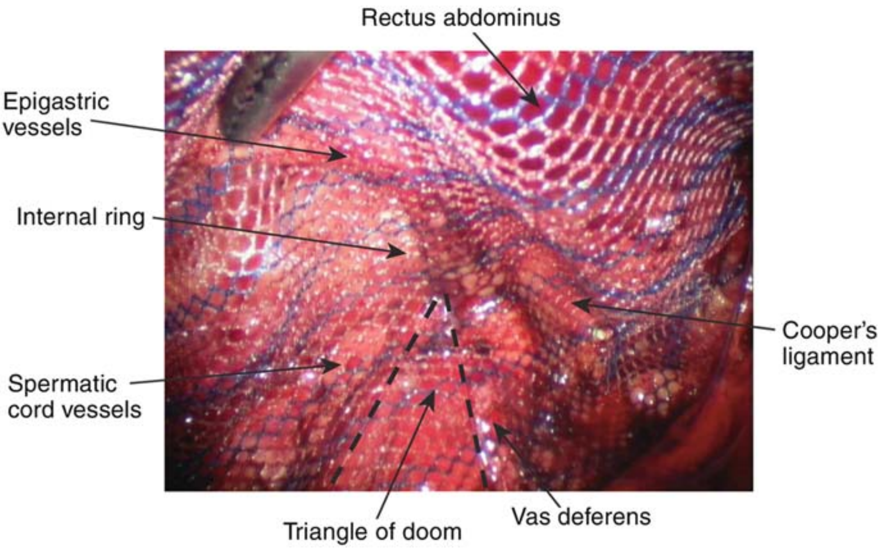

Fig. 29.3 Mesh repair from Fig. 29.1

Closure. Using a 10 cc syringe and spinal needle, infiltrate Marcaine throughout the retroperitoneal area of your dissection. Remove the ports and insufflation. Close the fascia of the 10-mm port site and close the skin. Compress the scrotum to try to evacuate air that may have dissected into it and inspect the testicles to confirm that they are appropriately present in the scrotum.

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Chapter 30
Incisional Hernia

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In general, incisional hernias should be repaired, as they tend to enlarge over time. The main complication of repairing incisional hernias is recurrence, which can occur up to 40% of the time, in some series. Mesh repair is typically indicated to provide a tension-free repair and reduce the risk of recurrence, although mesh repairs are associated with an increased risk of infection [1].

30.1 Open Repair of Incisional Hernias

Preoperative antibiotics covering skin flora are administered. The procedure is typically done under a general anesthetic. The scar from the prior incision is incised sharply with a knife. The subcutaneous fat is divided with great care to avoid injuring any viscera that may be in the hernial sac. Once the sac is identified, it is opened and the redundant sac is excised. The fascial edges around the hernial defect are dissected and identified.

Lahey clamps can be used to grab the contralateral fascial edge to retract it upwards, so the surgeon can perform adhesiolysis of the viscera under the fascial edge. This is done all around the hernial defect. Additionally, the superficial surface of the fascia is exposed by dissecting the subcutaneous fat off the fascia for a distance of at least 3 cm. The fascia is then prepared for the repair by removing necrotic or attenuated fascia to provide a healthy fascial edge.

A piece of permanent, coated mesh is cut to a size appropriate for the hernial defect, with at least 3 cm of overlap with the fascial edge. The mesh can be placed as an underlay or overlay [1]. The inlay or bridging repair, where mesh is approximated to the edge of the fascia, leads to a higher recurrence rate [2]. The main advantage of an underlay is the forces of the abdominal cavity working to push the mesh into

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the fascia of the abdominal wall. The main advantage of overlay mesh is less mesh exposure intraperitoneally. Care must be taken to position the mesh with the coated surface facing the peritoneal cavity to limit adhesions of the viscera onto the mesh.

The mesh is then approximated to the fascia with larger #0 or #1 interrupted horizontal mattress permanent sutures such as polypropylene. Because of the large dead space developed by the dissection of the skin and fat off the fascia, drains can be left in place to prevent a seroma. The skin is closed in a typical fashion.

30.2 Laparoscopic Repair of Incisional Hernias

The principle advantage of the laparoscopic approach to incisional hernias is the smaller wound size because the surgeon does not have to dissect the fascia from the overlying skin and fat. The operation is performed under a general anesthetic and preoperative antibiotics are typically administered. Depending on the complexity of the case, a urinary catheter and nasogastric tube may be placed. Sequential compression devices are used to prevent venous thrombosis.

Pneumoperitoneum is obtained and trocars placed with care to avoid visceral injury. Trocars should be placed as far away from the hernial defect as possible. Adhesiolysis is performed to reduce the hernial contents and dissect the viscera from the abdominal wall to allow for placement of mesh. The hernial sac may be excised to allow for better fixation of the mesh. Pneumoperitoneum is reduced and the size of the hernial defect is marked on the abdominal wall. The mesh should allow for at least 3 cm of overlap with the fascia to provide adequate fixation. A coated mesh is used to limit adhesions between the viscera and the mesh. It is cut to size and oriented appropriately. The surgeon can place the mesh on the anterior abdominal wall and mark on the wall the four points of the initial sutures. Four permanent anchoring sutures are placed in the mesh, located superiorly, inferiorly, to the left, and to the right. The tails are left long as these will be used to fix the mesh in place. The mesh is rolled up and placed into the abdominal cavity, unrolled, and positioned under the hernial defect.

Incisions are made in each of the four previously marked sites and a suture-passing device is used to bring up the appropriate sutures through each site. Through each incision, the suture-passing device is passed through two separate fascial sites and each of the two tails is brought up through one of those fascial sites. The sutures are then tied down, thus positioning the mesh on the abdominal wall. A tacking device is then used to approximate the mesh circumferentially to the anterior abdominal wall. Additional incisions are then placed through the skin to provide for additional sutures to secure the mesh to the fascia. A suture-passing device passes one of the stitches through the fascia and mesh into the peritoneum. The device then releases the stitch and makes a second pass through the same skin incision but through a separate fascia/mesh site to grab the stitch and pull it out of the body. The stitch is then tied to further secure the mesh.

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Chapter 31
Umbilical Hernia

David M. Melnick and Jacquelynn D. Arbuckle

The surgeon should appropriately anesthetize the periumbilical area. An infraumbilical incision is made (Fig. 31.1) and the subcutaneous fat is dissected down to the linea alba and umbilical stalk below. The umbilical stalk is encircled and divided to free the hernia sac from the skin, with care to avoid injuring the skin. The hernia contents are dissected free from the fascia and hernia defect (Fig. 31.2) reduced, and the hernia defect is closed either primarily or with mesh (Fig. 31.3) Mesh has the advantage of decreased recurrence, but with the disadvantage of an increased rate of infection (1, 2).

Fig. 31.1 Umbilical Hernia incision

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For a primary repair, the fascial edges can be approximated with interrupted braided polyester sutures (Ethibond, Johnson & Johnson.) Next, the umbilicus should be reapproximated to the fascia with an interrupted absorbable suture, and the skin closed. A pressure dressing will help prevent seromas from forming.

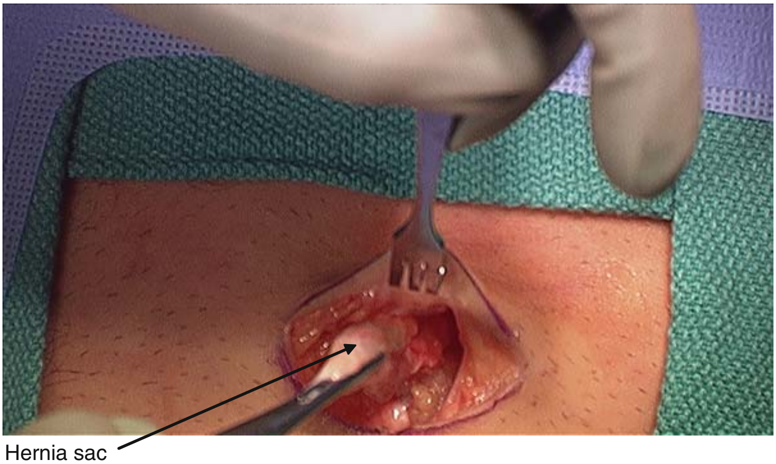

Fig. 31.2 Dissection of hernia contents

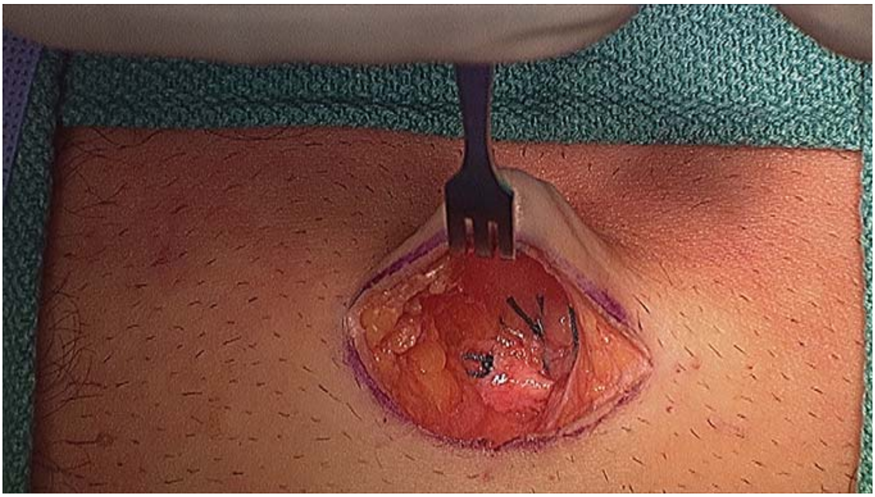

Fig. 31.3 Closure of fascial defect

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Part VIII
Hepatobiliary Surgery

Section Editor: Clifford S. Cho

Chapter 32
Hepatic Procedures

Andrew J. Russ and Clifford S. Cho

32.1 Introduction

In this chapter, the operative conduct of common hepatobiliary procedures will be described. It is important to recognize that the surgical management of many hepatobiliary disorders will require a combination of procedures; for example, surgical extirpation of hilar cholangiocarcinoma with predominant left-sided involvement will require cholecystectomy, extrahepatic bile duct resection, portal lymphadenectomy, left hemihepatectomy, and biliary-enteric reconstruction. Operations of the liver and bile ducts demand solid familiarity with hepatobiliary anatomy, which can vary greatly from patient to patient. Therefore, careful preoperative study of individual patient imaging studies is of critical importance.

32.1.1 Incision

A generous right subcostal incision (dotted line) or vertical upper midline incision with right lateral extension (solid line) permits adequate exposure of the entire liver. Left lateral sectionectomy can be performed through a vertical upper midline incision without lateral extension.

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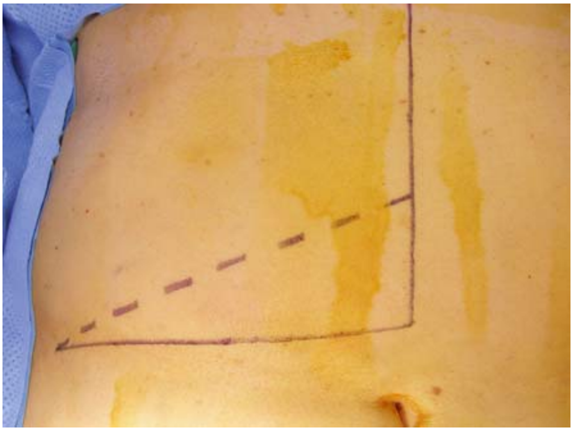
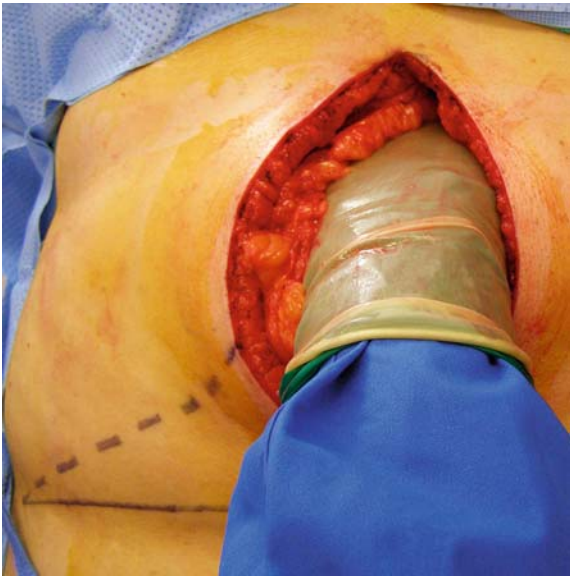
Fig. 32.1



For oncological resections, careful inspection and palpation of the liver and peritoneal surfaces is performed to identify occult metastases that may potentially alter operative conduct. In selected cases, diagnostic laparoscopy may be useful in this regard.

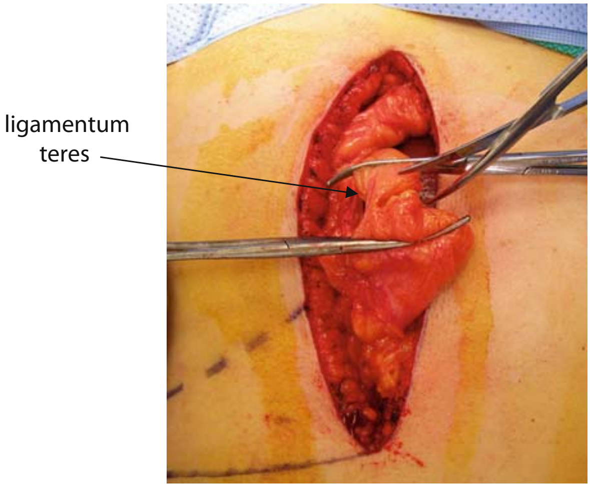
Fig. 32.2



32.1.2 Exposure

The ligamentum teres is ligated and divided and its proximal aspect can be used as a handle with which to elevate the left hemiliver.

Fig. 32.3



The falciform ligament is divided close to the liver from the ligamentum teres toward the confluence of the hepatic veins, and retractors are positioned to provide exposure of the liver.

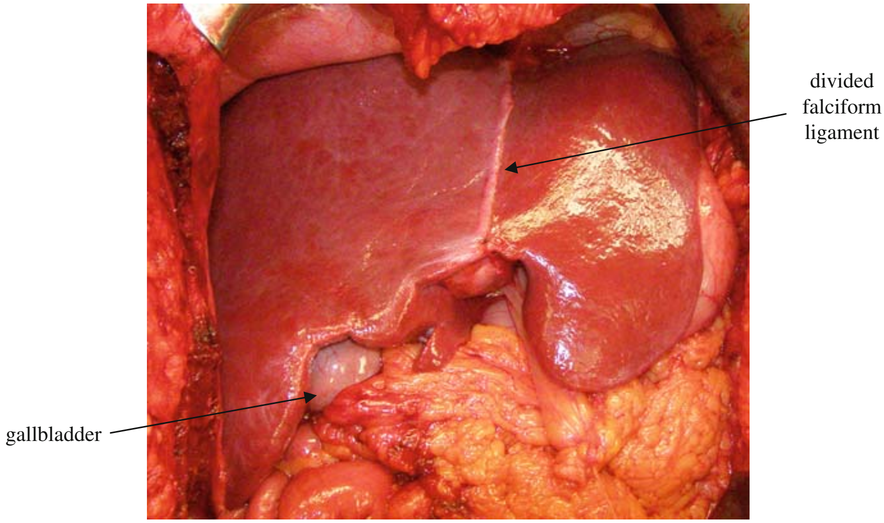
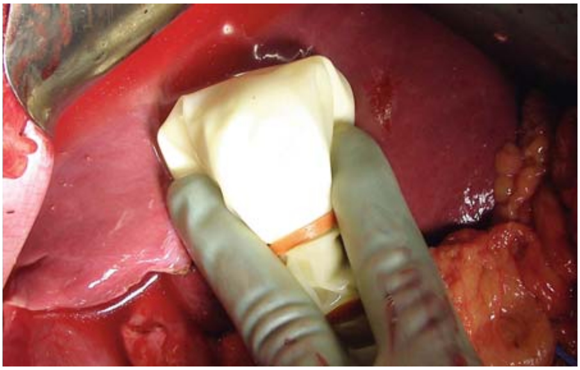


Fig. 32.4

Intraoperative hepatic ultrasonography is performed for evaluation of hepatic anatomy, tumor localization, and to exclude previously unidentified pathology.

Fig. 32.5



32.2 Right Hemihepatectomy (Segmentectomy V-VIII)

32.2.1 Exposure

The retroperitoneal attachments of the right hemiliver are incised, permitting elevation and medial rotation of the right hemiliver off the inferior vena cava and right adrenal gland. Here, the right triangular ligament is being incised.

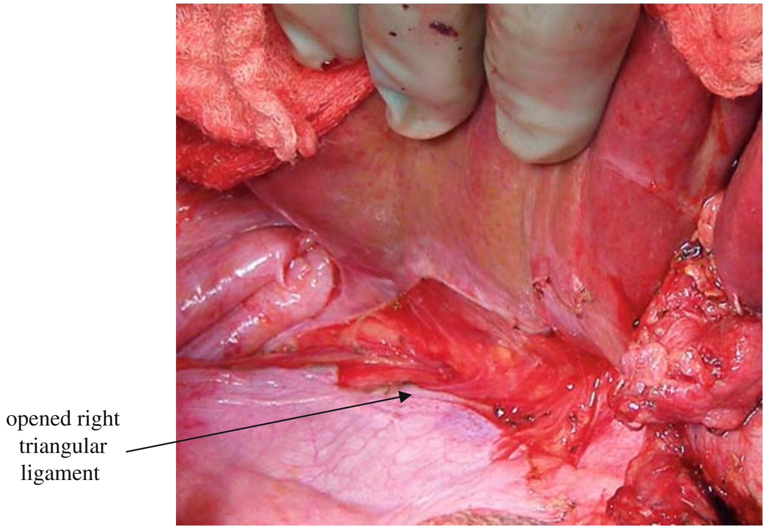


Fig. 32.6

32.2.2 Cholecystectomy

A cholecystectomy is performed (see Chapter 33, Section 33.1.1).

32.2.3 Inflow Control

The peritoneum overlying the porta hepatis is incised.

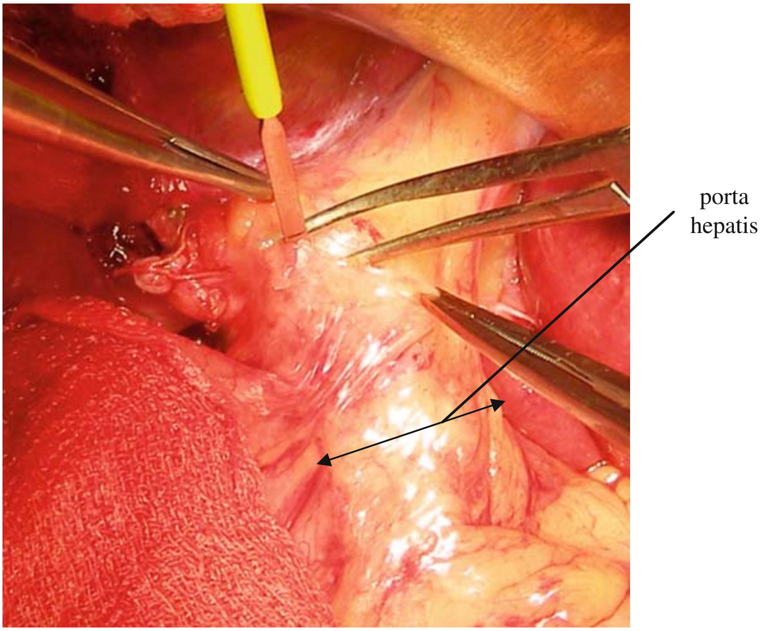


Fig. 32.7

The right hepatic artery is identified, ligated, and divided.

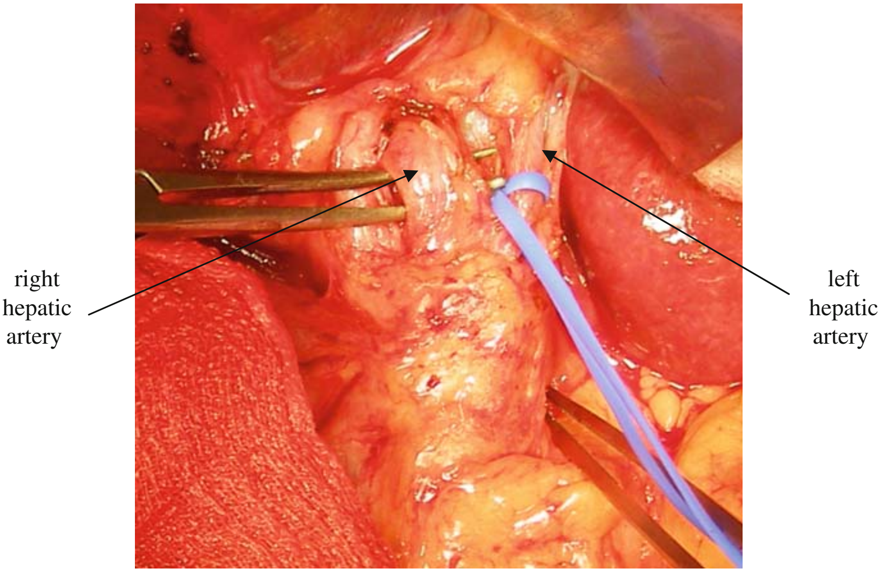


Fig. 32.8

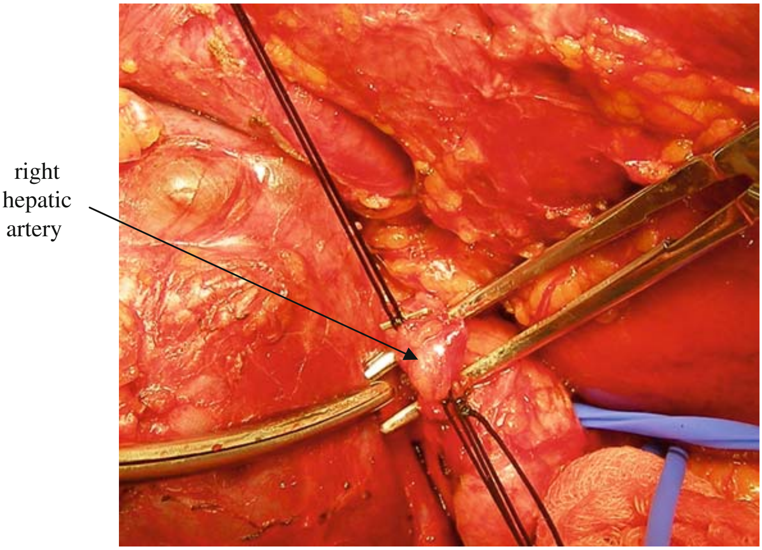


Fig. 32.9

Division of the right hepatic artery facilitates exposure of the right portal vein, which is ligated and divided.

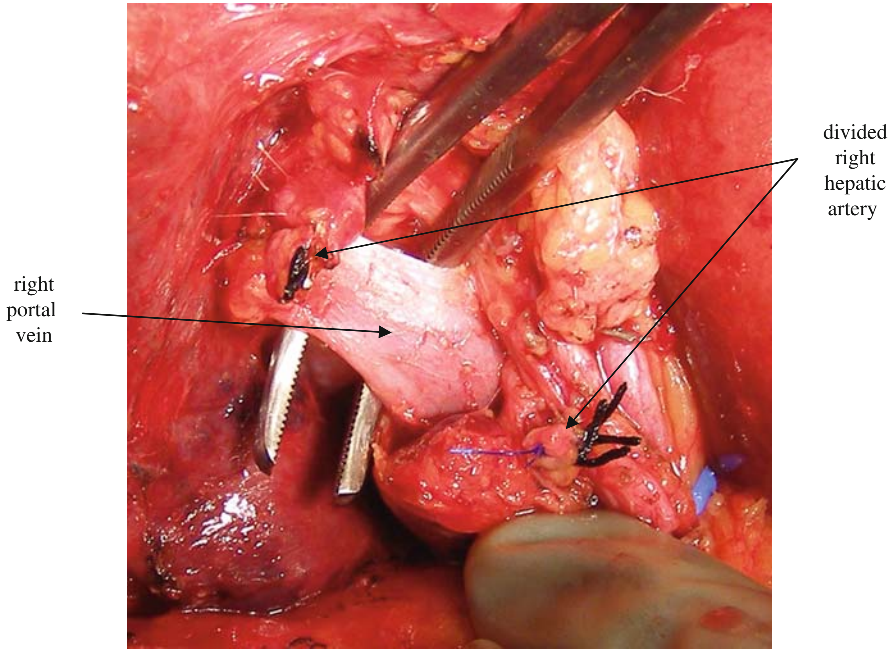


Fig. 32.10

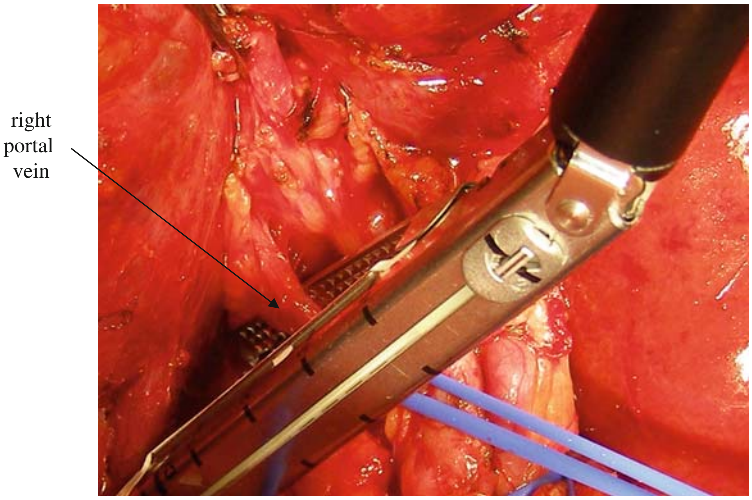
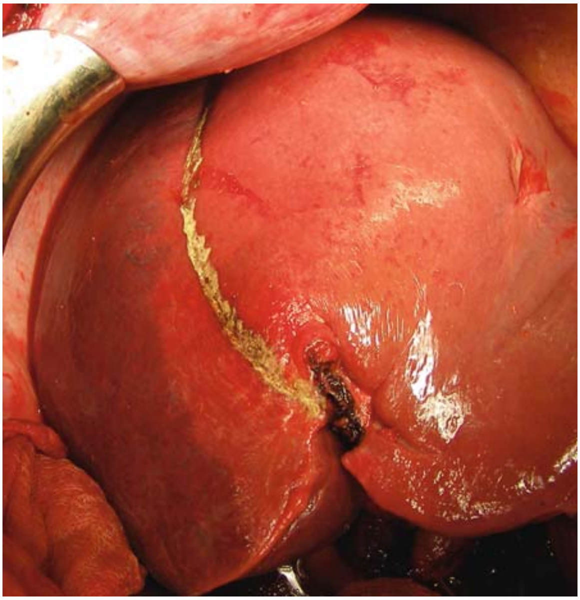


Fig. 32.11

Division of the right hepatic inflow results in ischemic demarcation of the right hemiliver. The line of planned parenchymal transection is marked with electrocautery.

Fig. 32.12



32.2.4 Outflow Control

Multiple draining veins between the right hemiliver and inferior vena cava are individually ligated and divided.

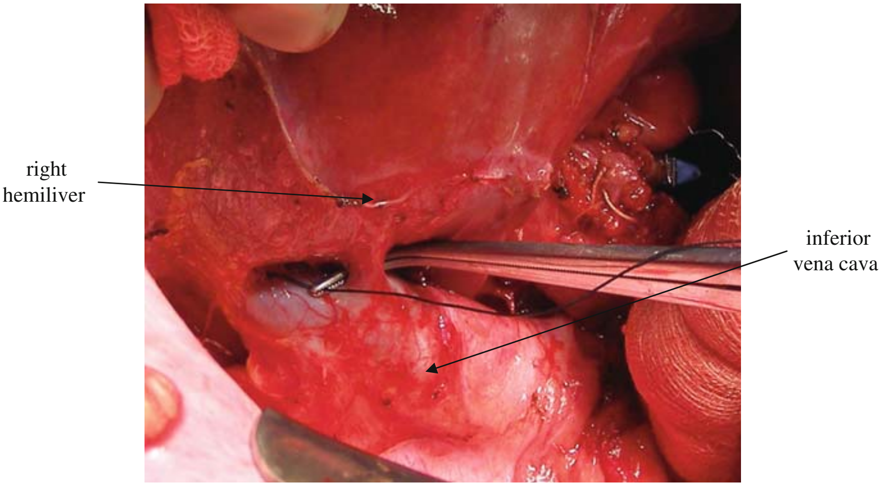


Fig. 32.13

Dissection along the confluence of the hepatic veins permits identification of the junction between the right and middle hepatic veins. The right hepatic vein is encircled and transected.

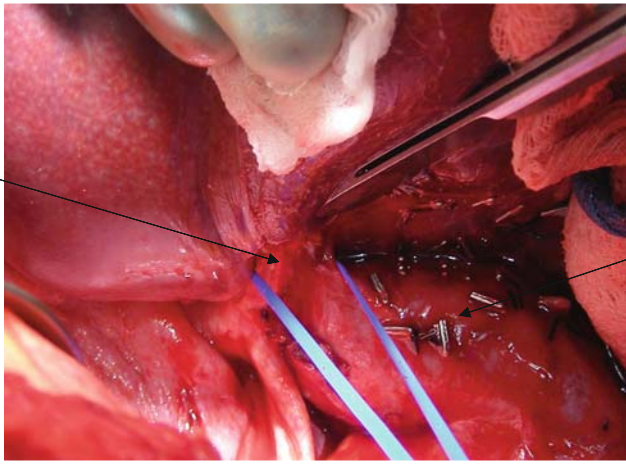


Fig. 32.14

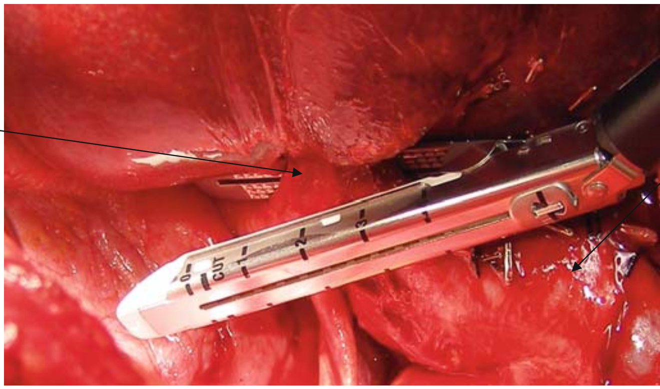


Fig. 32.15

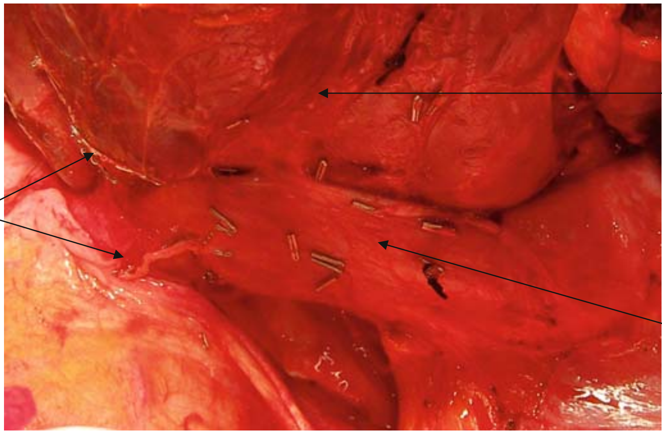


Fig. 32.16

32.2.5 Parenchymal Transection

A Pringle maneuver may be performed by intermittently occluding the porta hepatis.

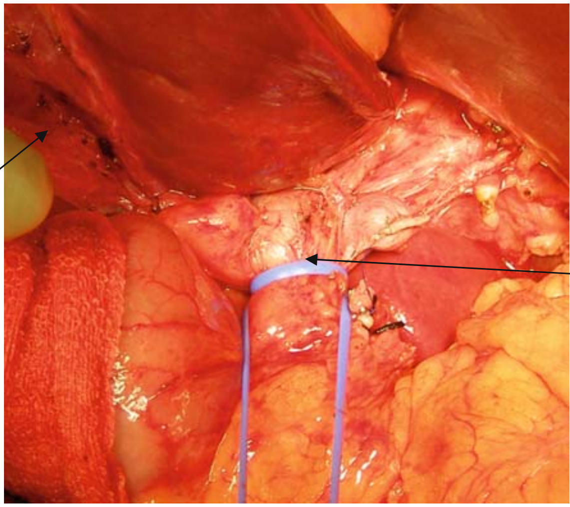


Fig. 32.17

Stay sutures placed along either side of the planned parenchymal transaction plane permit elevation and separation of the right and left hemilivers, facilitating exposure.

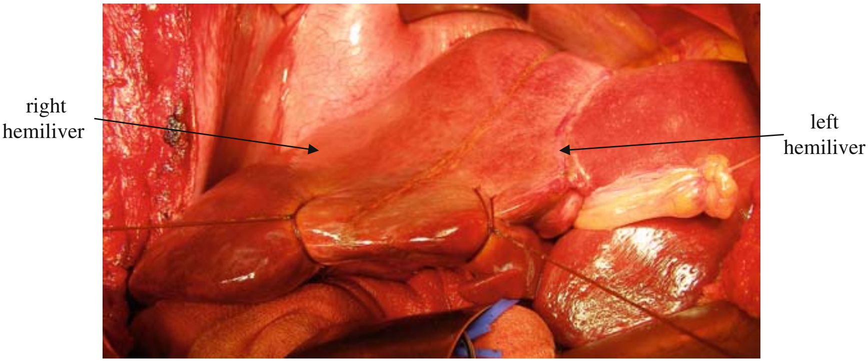


Fig. 32.18

Glisson’s capsule can be divided sharply; alternatively, parenchymal transaction can also be initiated using the harmonic scalpel.

Fig. 32.19

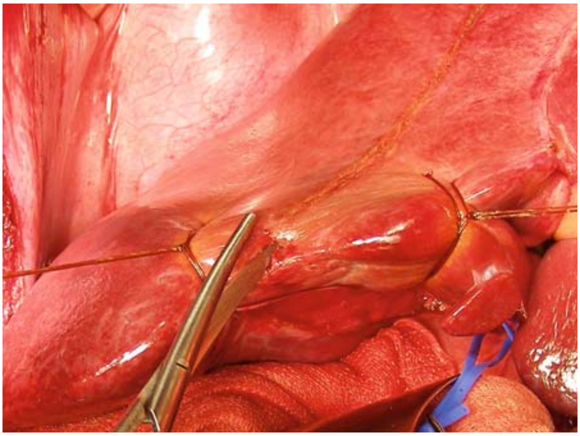
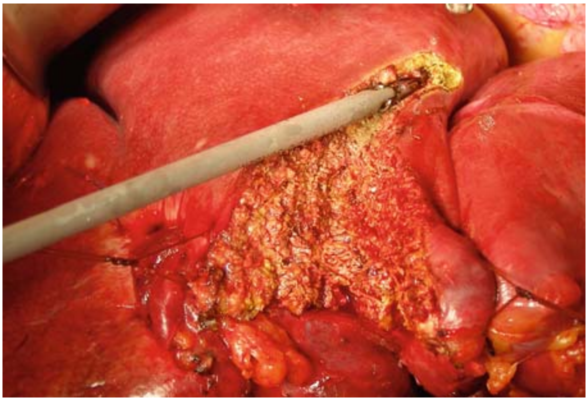


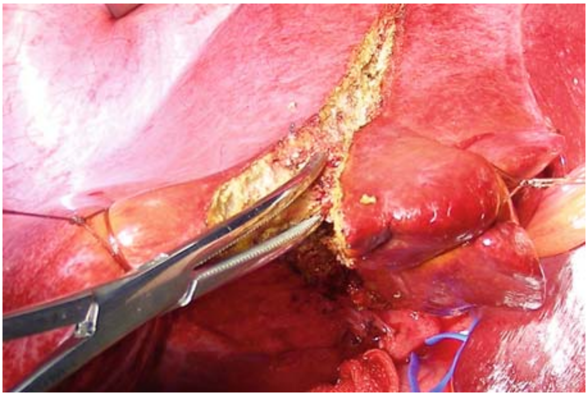
Fig. 32.20

Fig. 32.21



Crushing the hepatic parenchyma with a clamp permits visualization of biliary and vascular structures, which are individually ligated and divided.

Fig. 32.22



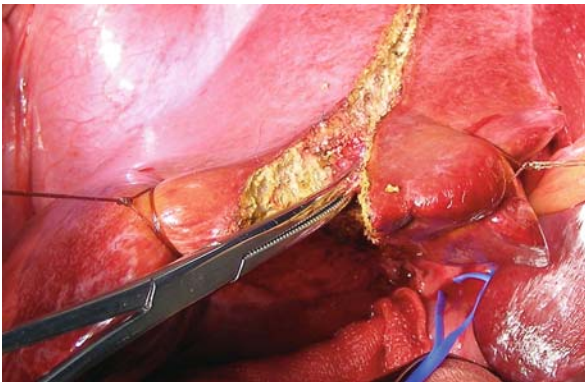
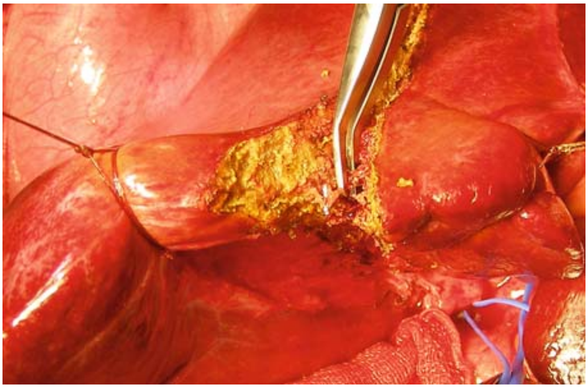


Fig. 32.23

Fig. 32.24



Larger structures such as the middle hepatic vein may be divided with a stapler.

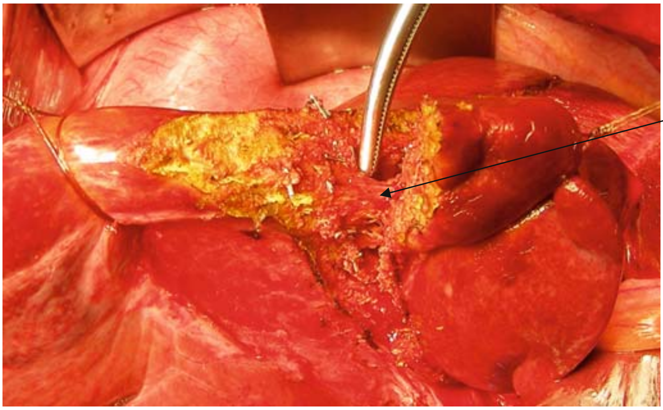
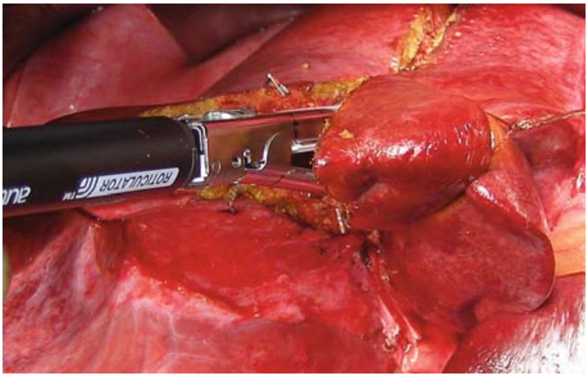


Fig. 32.25

Fig. 32.26



The specimen is removed, the cut surface of the liver is inspected to insure hemostasis and absence of bile leakage, and the abdomen is closed.

32.3 Left Hemihepatectomy (Segmentectomy II, III, IV)

32.3.1 Exposure

The diaphragmatic attachments of the left hemiliver (the left triangular ligament) are divided, permitting medial rotation of the left lateral section of the liver.

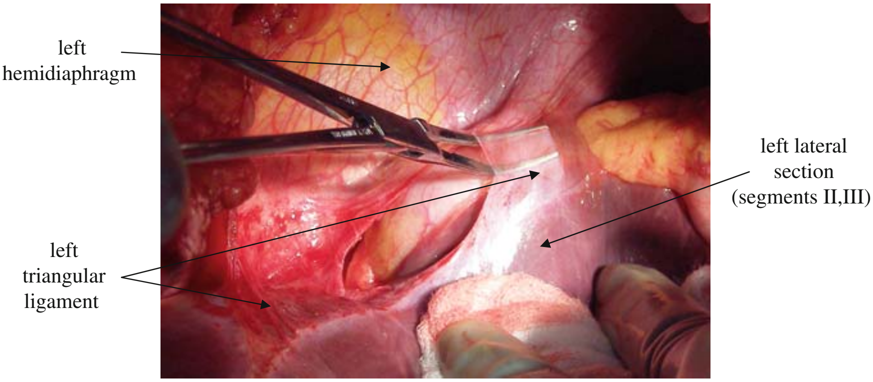


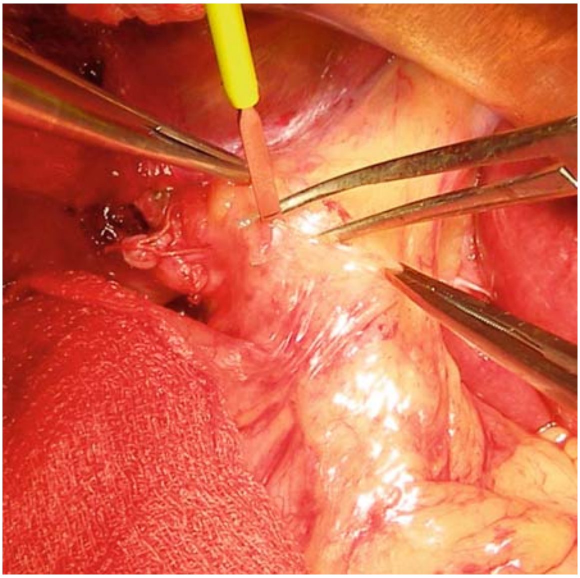
Fig. 32.27

32.4 Cholecystectomy (see Chapter 33, Section 33.1.1)

32.4.1 Inflow Control

The peritoneum overlying the porta hepatis is incised.

Fig. 32.28



The left hepatic artery is identified, ligated, and divided.

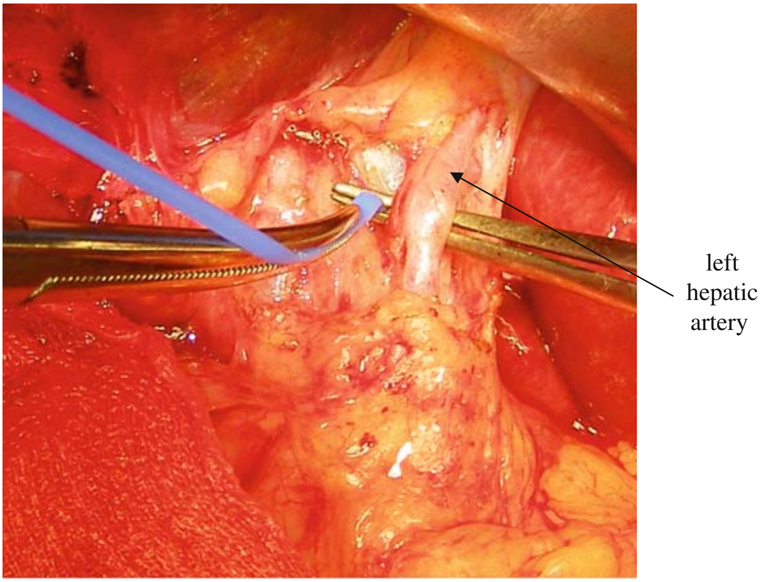


Fig. 32.29

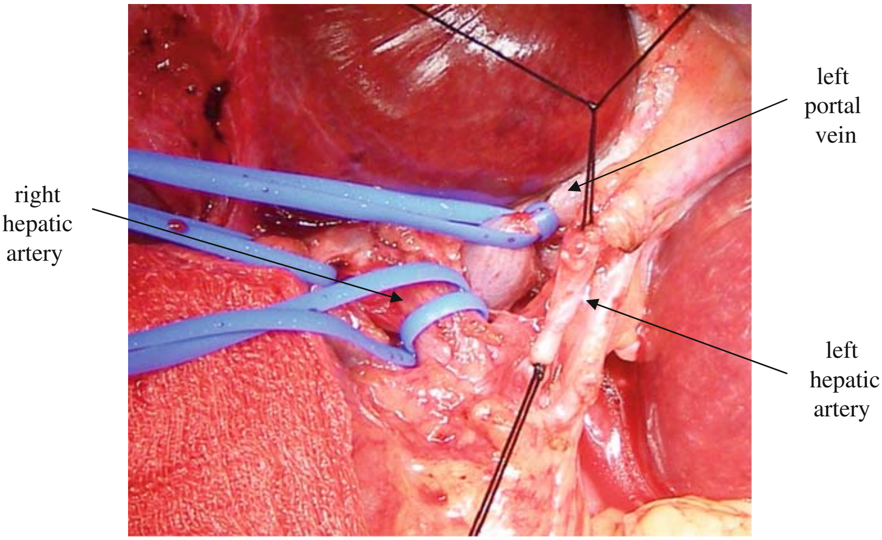


Fig. 32.30

Division of the left hepatic artery facilitates exposure of the left portal vein, which is ligated and divided. If the caudate lobe (segment I) is to be preserved, care is taken to divide the left portal vein distal to the segment I branch.

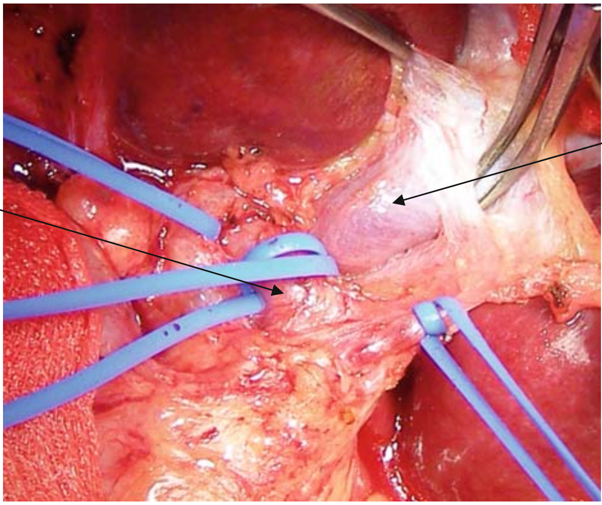


Fig. 32.31

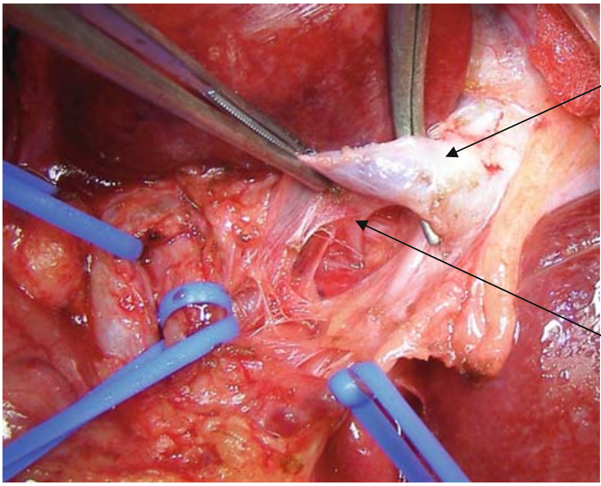


Fig. 32.32

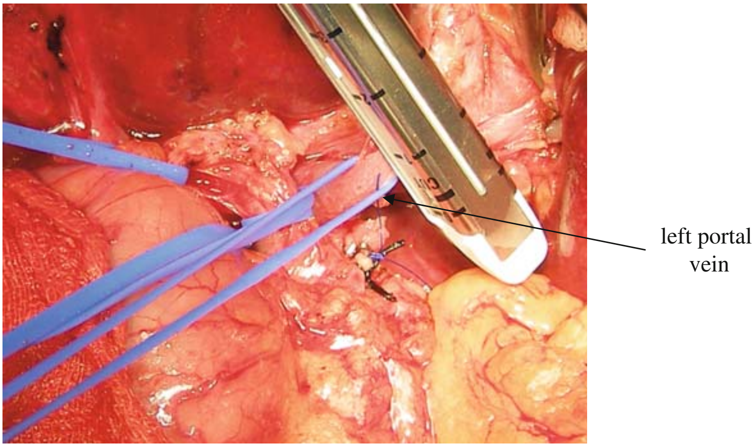


Fig. 32.33

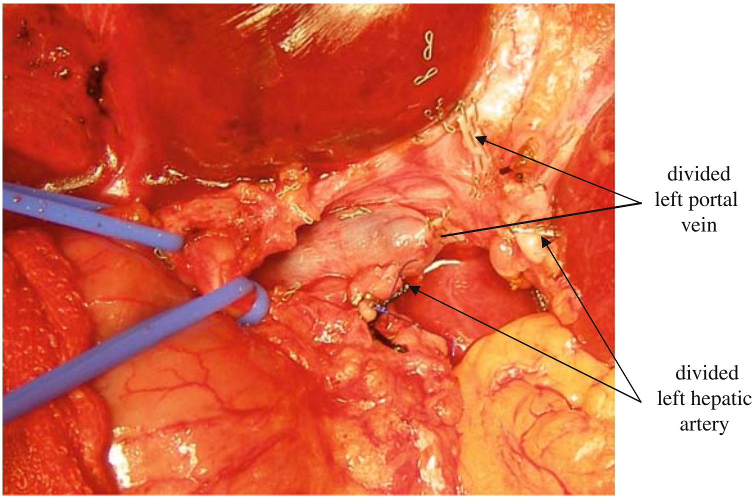


Fig. 32.34

Division of the left hepatic inflow results in ischemic demarcation of the left hemiliver.

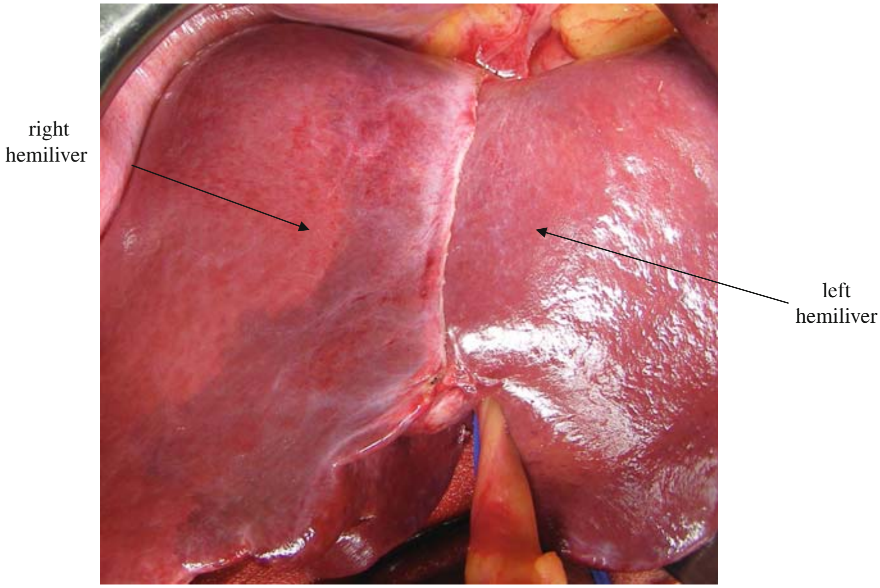


Fig. 32.35

32.4.2 *Outflow Control*

Dissection along the confluence of the hepatic veins permits identification of the junction between the left and middle hepatic veins.

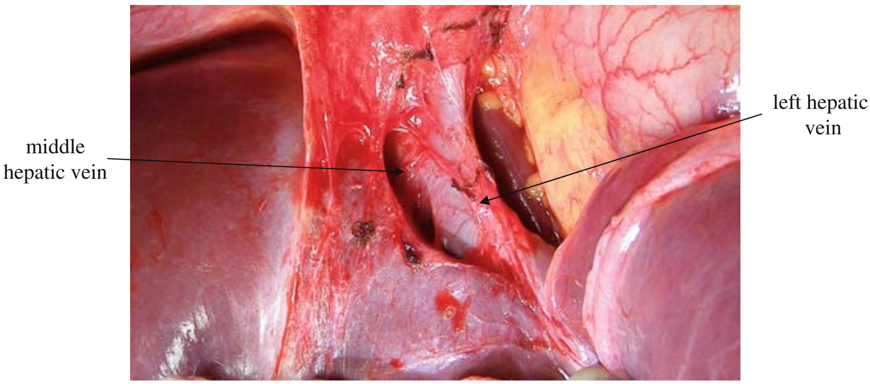


Fig. 32.36

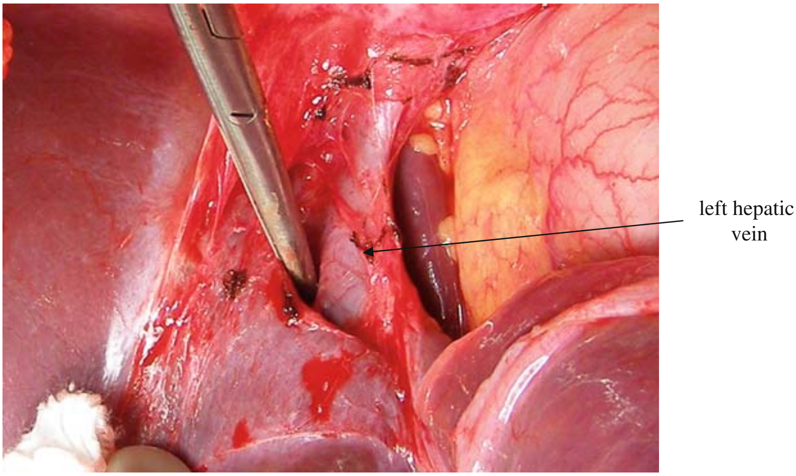


Fig. 32.37

Division of the ligamentum venosum along the undersurface of the left lateral section of the liver facilitates exposure of the left hepatic vein.

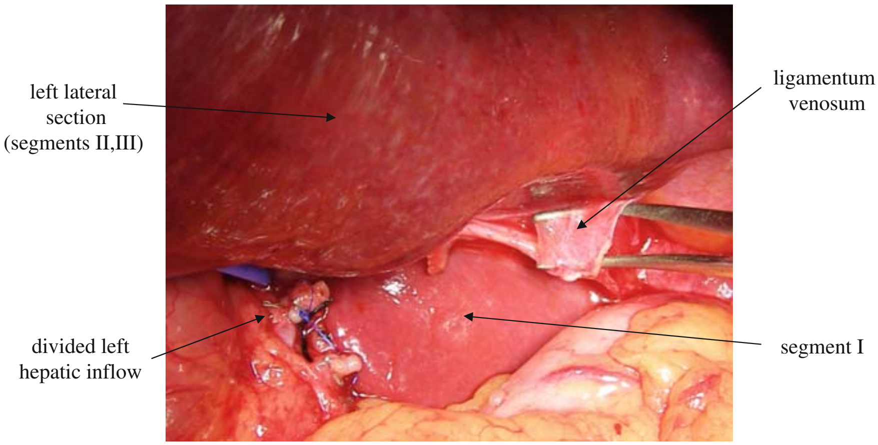


Fig. 32.38

The left hepatic vein is encircled and divided.

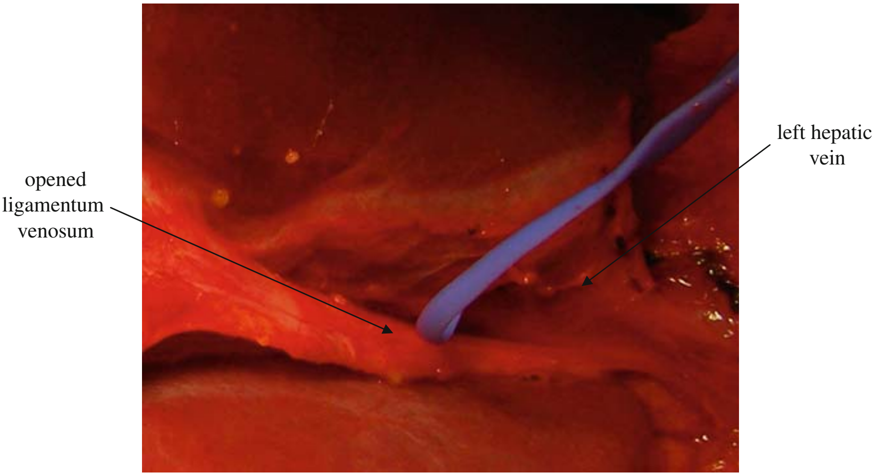


Fig. 32.39

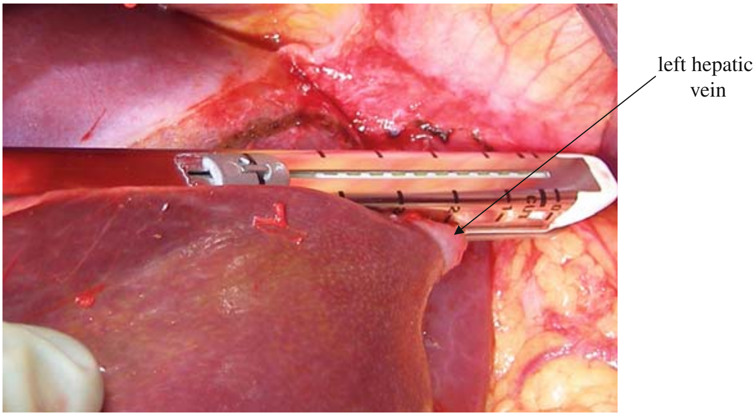


Fig. 32.40

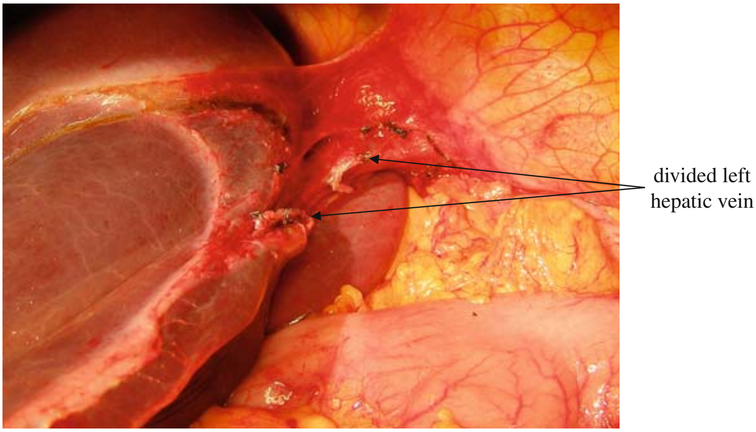


Fig. 32.41

32.4.3 Parenchymal Transection

A Pringle maneuver may be performed by intermittently occluding the porta hepatis.

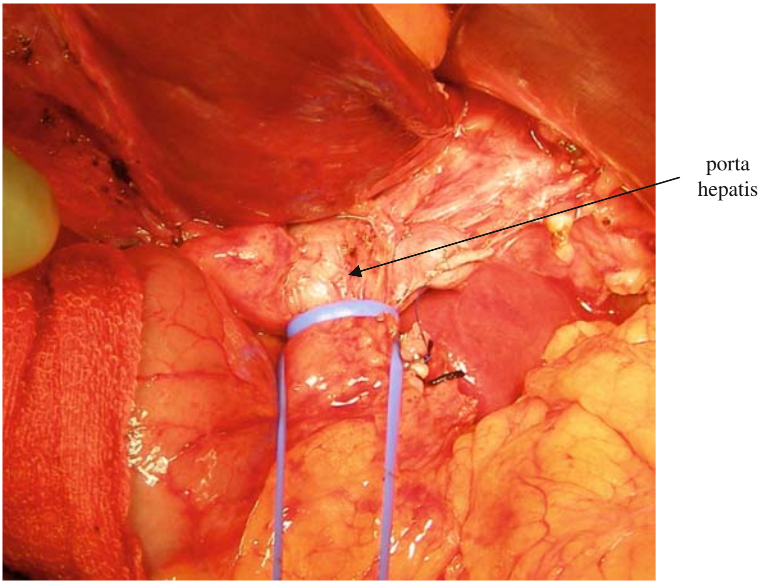


Fig. 32.42

Stay sutures placed along either side of the planned parenchymal transaction plane permit elevation and separation of the right and left hemilivers, facilitating exposure.

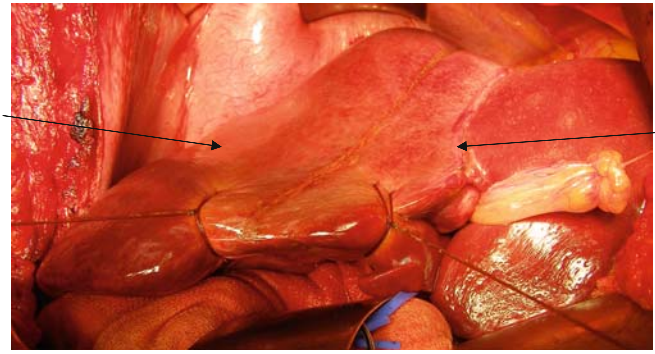


Fig. 32.43

Glisson's capsule can be divided sharply; alternatively, parenchymal transaction can also be initiated using the harmonic scalpel.

Fig. 32.44

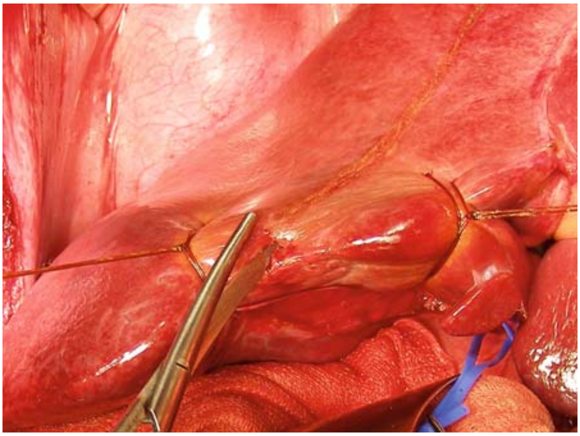
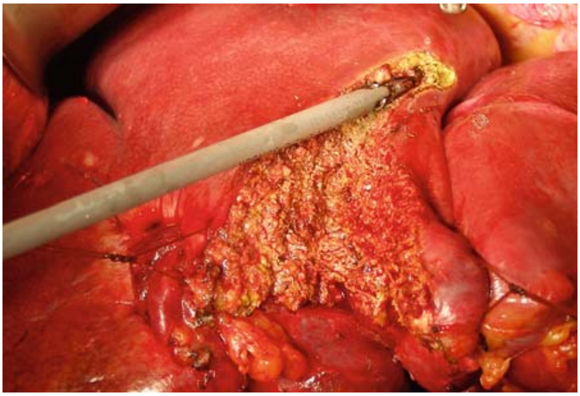


Fig. 32.45

Fig. 32.46



Crushing the hepatic parenchyma with a clamp permit visualization of biliary and vascular structures, which are individually ligated and divided.

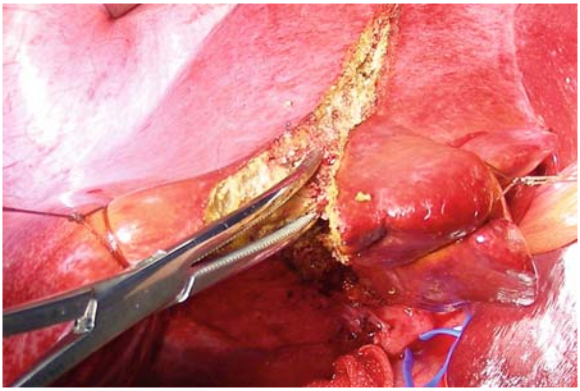


Fig. 32.47

Fig. 32.48

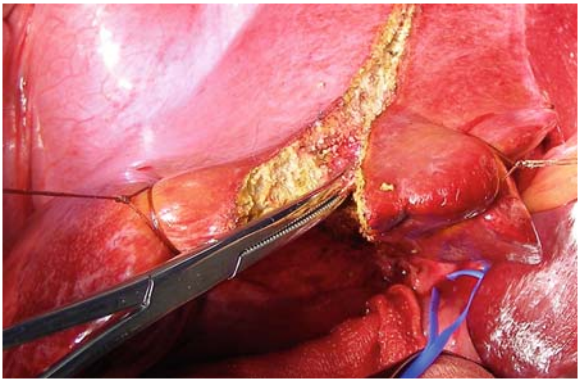
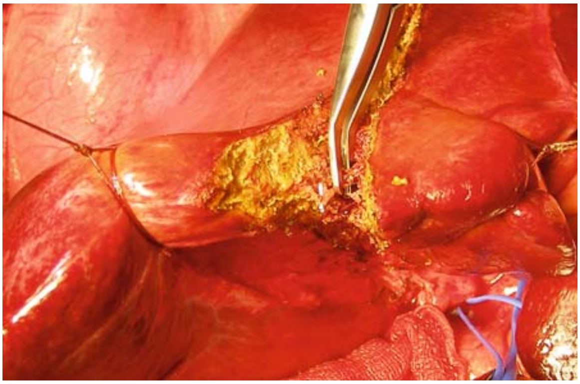


Fig. 32.49



Larger structures such as the middle hepatic vein may be divided with a stapler.

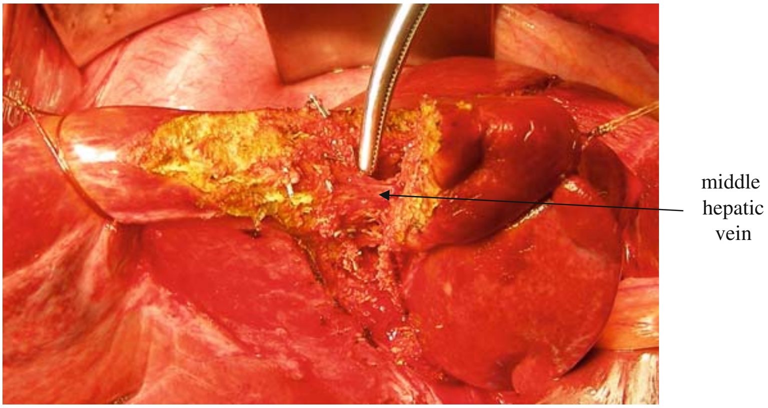
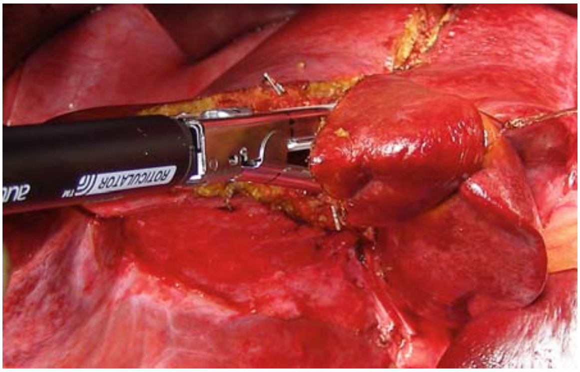


Fig. 32.50

Fig. 32.51



The specimen is removed, the cut surface of the liver is inspected to insure hemostasis and absence of bile leakage, and the abdomen is closed.

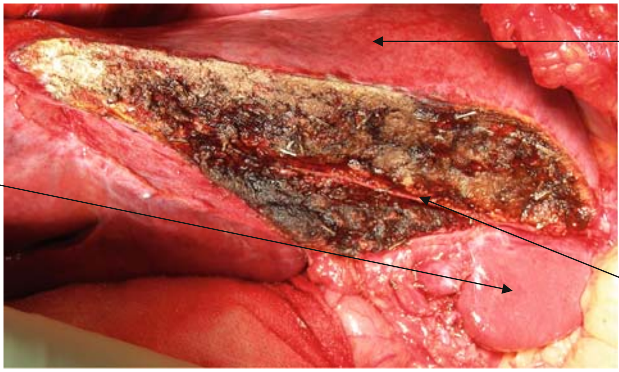


Fig. 32.52

32.5 Left Lateral Sectionectomy (Segmentectomy II, III)

32.5.1 Exposure

The diaphragmatic attachments of the left hemiliver (the left triangular ligament) are divided, permitting medial rotation of the left lateral section of the liver.

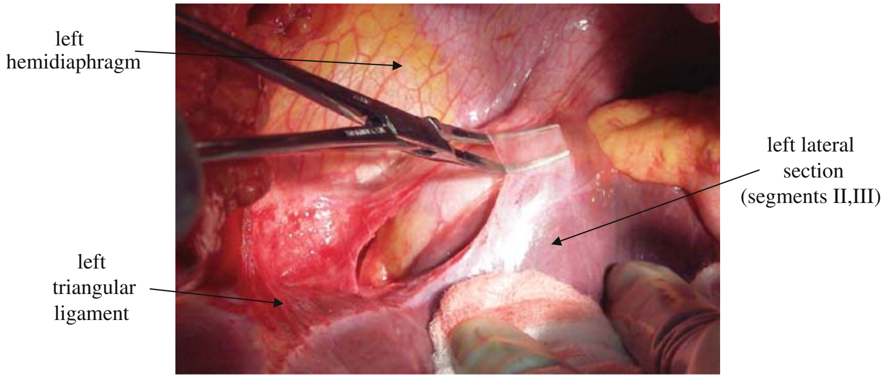


Fig. 32.53

32.5.2 Inflow Control

The ligamentum teres is elevated and any hepatic parenchyma overlying the umbilical fissure is divided.

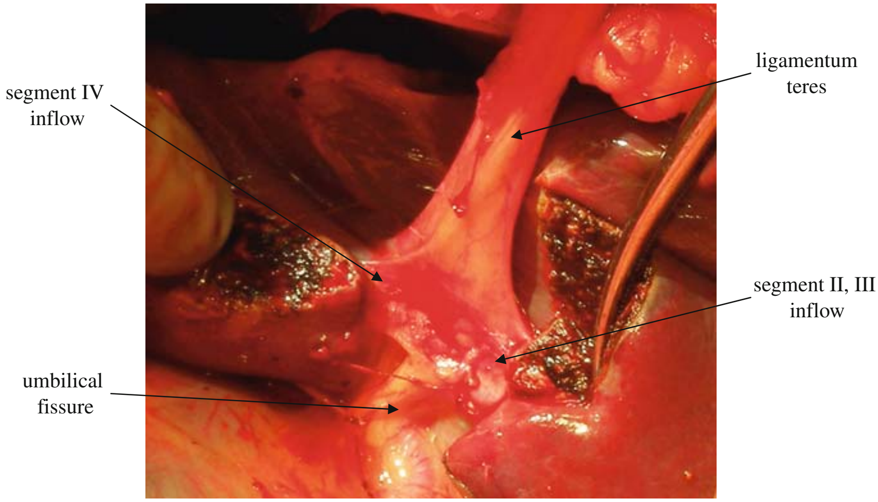


Fig. 32.54

The inflow vessels into segments II and III are ligated.

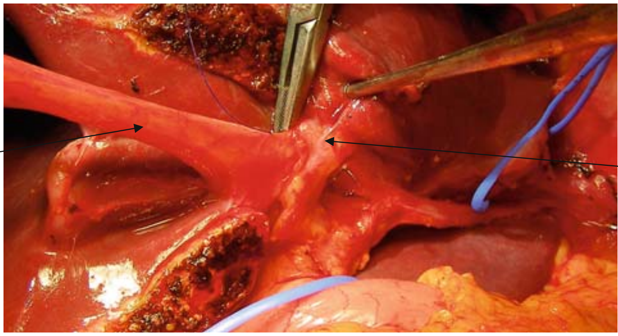
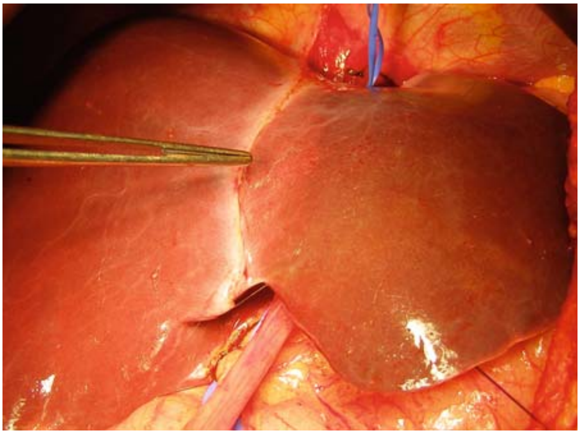


Fig. 32.55

Division of the segment II/III inflow results in demarcation of the left lateral section.

Fig. 32.56



32.5.3 Parenchymal Transection

A Pringle maneuver may be performed by intermittently occluding the porta hepatis.

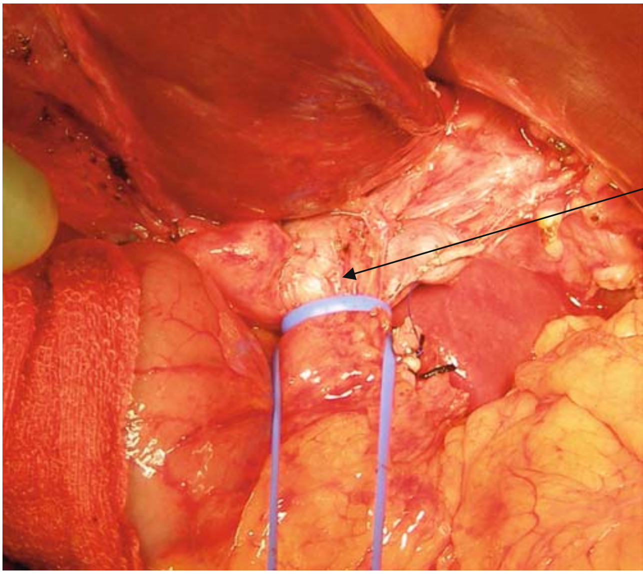
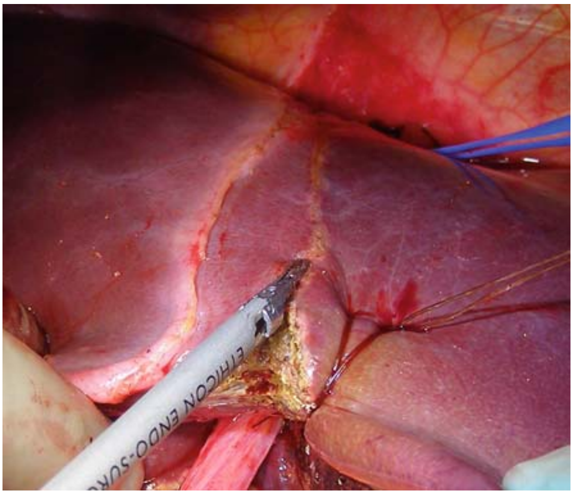


Fig. 32.57

Stay sutures placed along either side of the planned parenchymal transection plane permit separation and elevation of the left lateral section of the liver, facilitating exposure. Glisson's capsule can be divided sharply; alternatively, parenchymal transaction can also be initiated using the harmonic scalpel.

Fig. 32.58



Crushing the hepatic parenchyma permits visualization of biliary and vascular structures, which are ligated and divided. Larger structures including the left hepatic vein may be divided with a stapler (see Parenchymal Transection in Right Hemihepatectomy or Left Hemihepatectomy). The specimen is removed and the cut surface of the liver is inspected to insure hemostasis and absence of bile leakage.

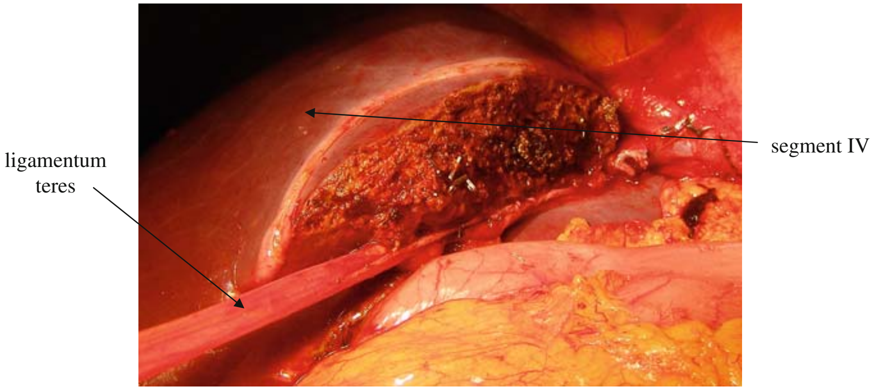


Fig. 32.59

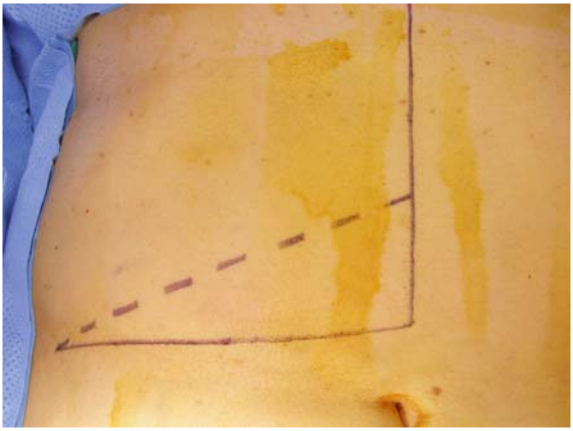
Chapter 33
Biliary Procedures

Andrew J. Russ and Clifford S. Cho

33.1 Incision

A right subcostal incision (dotted line) permits adequate exposure of the liver hilus.

Fig. 33.1



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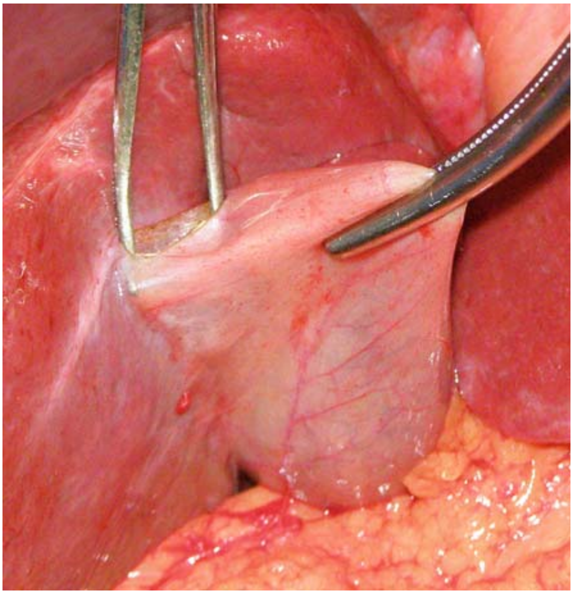
H. Chen (ed.), *Illustrative Handbook of General Surgery*,
DOI 10.1007/978-1-84882-089-0_33, © Springer-Verlag London Limited 2010

33.1.1 Open Cholecystectomy

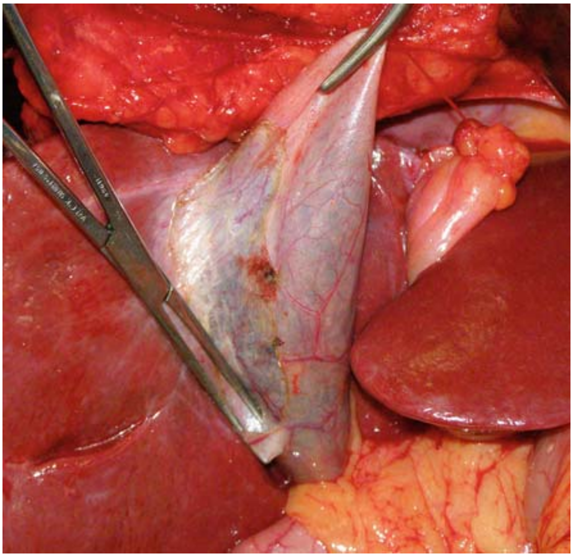
The peritoneum overlying the fundus of the gallbladder is incised.

Fig. 33.2



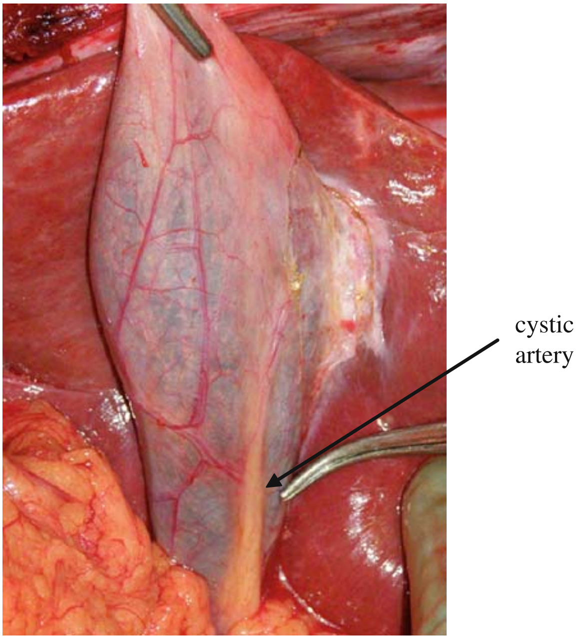
The peritoneum enveloping the gallbladder is incised along both sides of the gallbladder.

Fig. 33.3



The course of the cystic artery is shown here.

Fig. 33.4



The gallbladder is dissected out of the gallbladder fossa.

Fig. 33.5

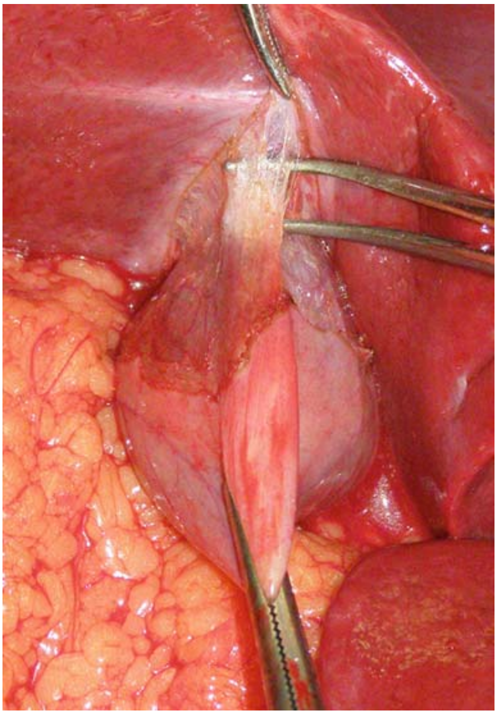
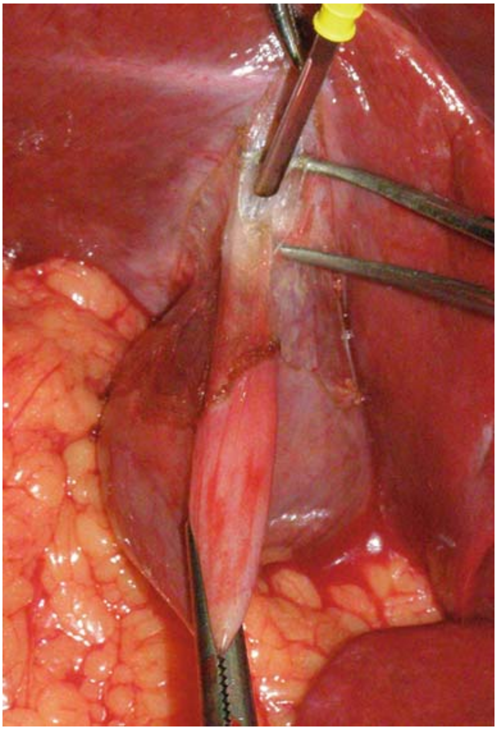
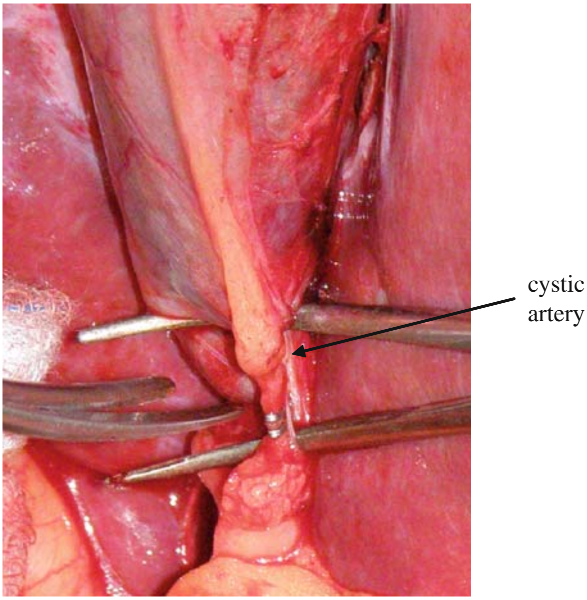


Fig. 33.6



The cystic artery is ligated and divided.

Fig. 33.7



The cystic duct is ligated and divided.

Fig. 33.8

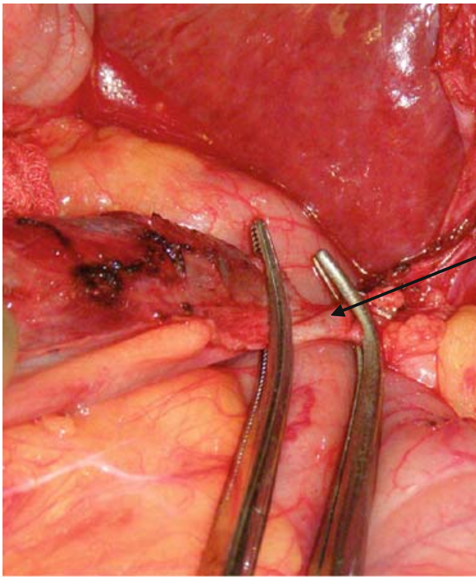
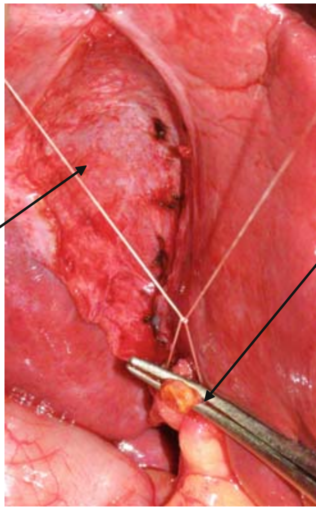


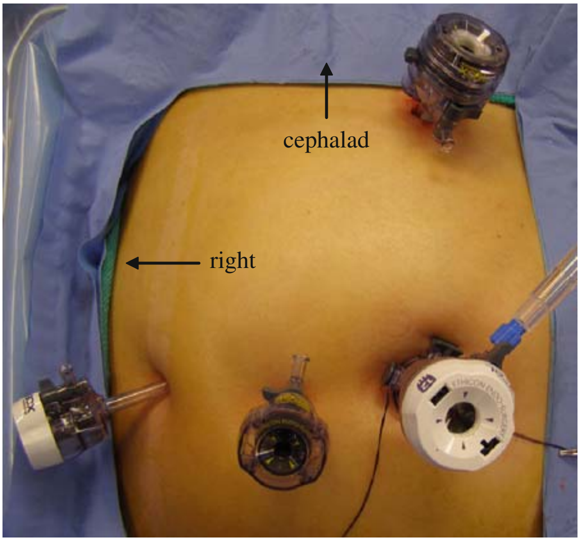
Fig. 33.9



33.2 Laparoscopic Cholecystectomy

A 5 or 10 mm supraumbilical port is used for camera access, a 5 or 10 mm subxiphoid port is used for dissection, and two right-sided 5-mm ports are used for retraction.

Fig. 33.10



Atraumatic grasping forceps are placed through the right-sided ports to elevate the gallbladder in both cephalad and rightward directions to expose the triangle of Calot. The peritoneum overlying the base of the gallbladder and the triangle of Calot is incised, exposing the cystic duct and cystic artery. The cystic duct and artery are doubly clipped and divided.

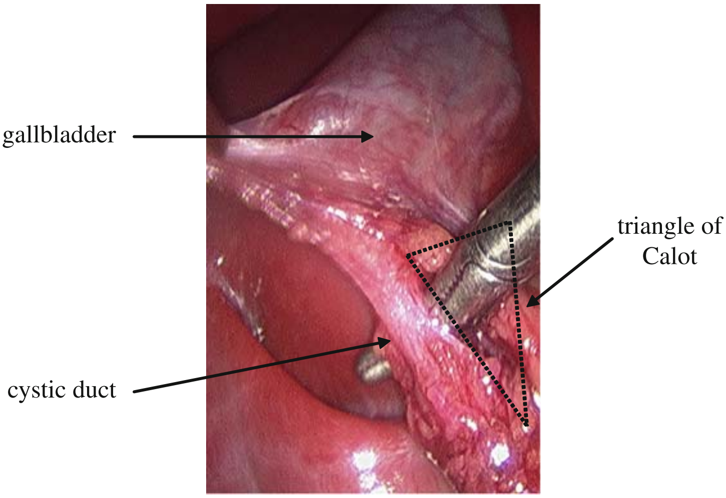


Fig. 33.11

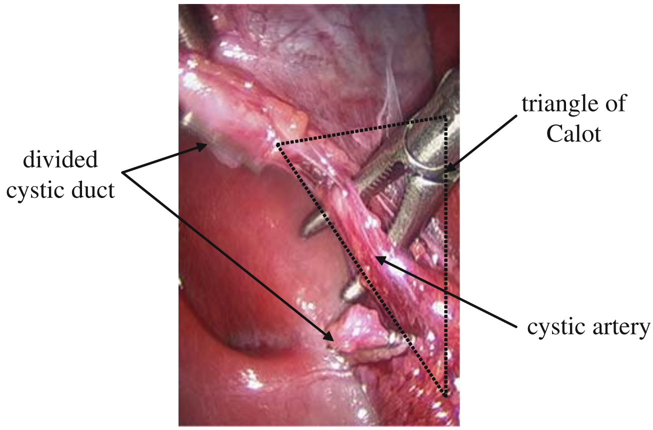


Fig. 33.12

The gallbladder is dissected out of the gallbladder fossa using electrocautery, with care taken to avoid inadvertent bile spillage.

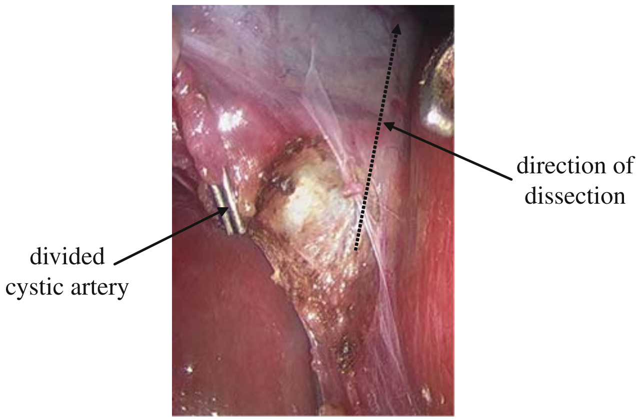


Fig. 33.13

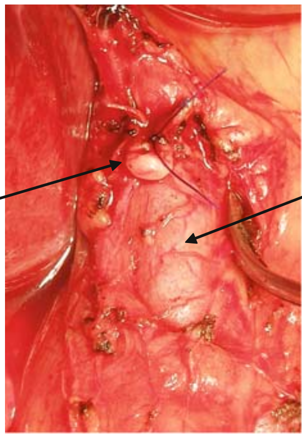
The resected gallbladder is placed into a bag and removed.

Fig. 33.14

33.3 Common Bile Duct Exploration

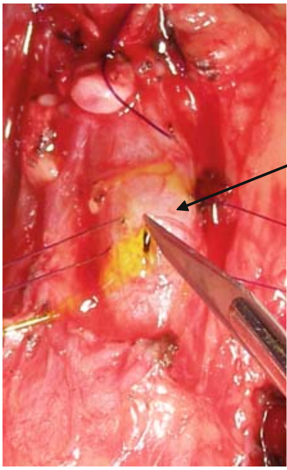
The common bile duct is exposed in the porta hepatis.

Fig. 33.15



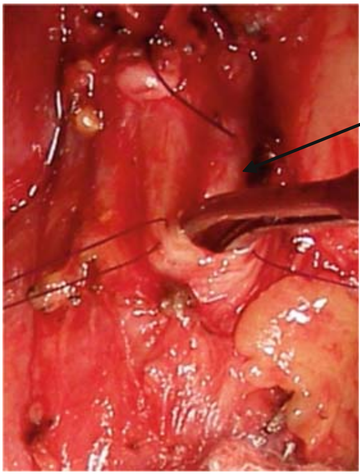
Stay sutures are placed on either side of the planned choledochotomy and the common bile duct is opened.

Fig. 33.16



The common bile duct is explored, then closed over a T-tube.

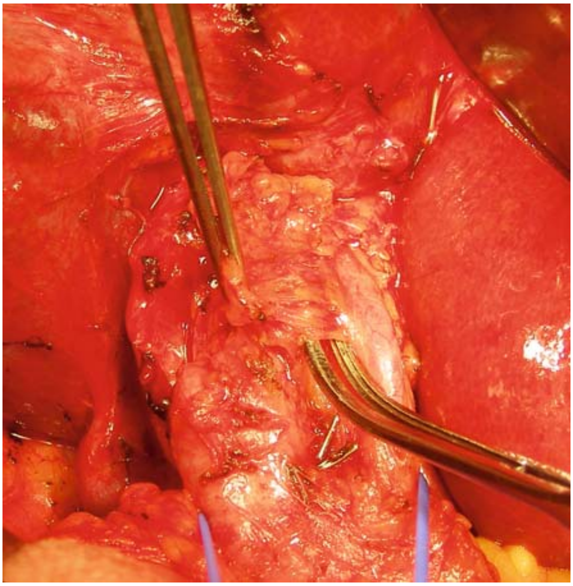
Fig. 33.17



33.4 Extrahepatic Bile Duct Resection

The peritoneum is incised to permit identification of the common bile duct.

Fig. 33.18



The common bile duct is transected at the base of the porta hepatis.

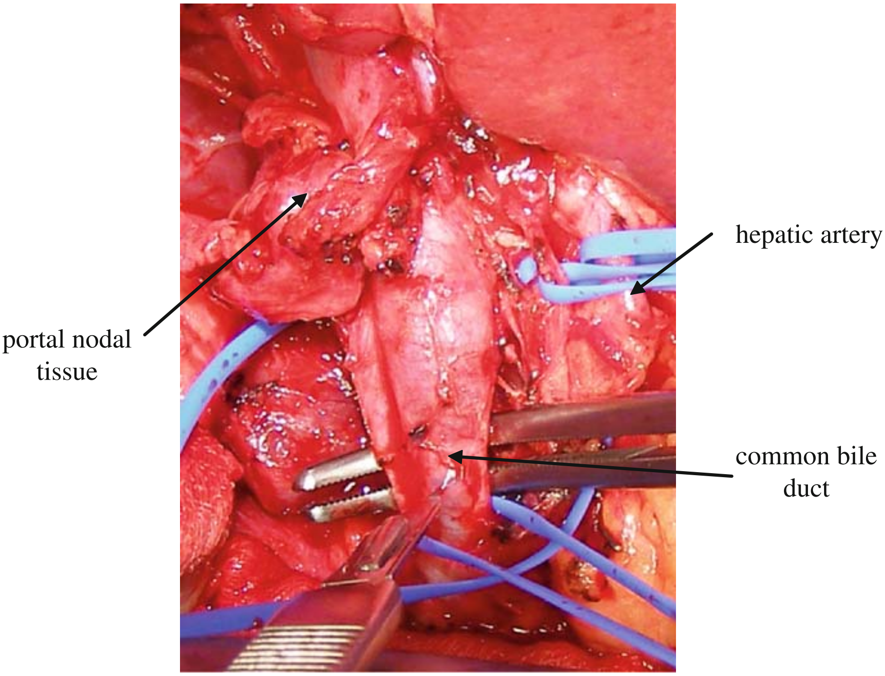


Fig. 33.19

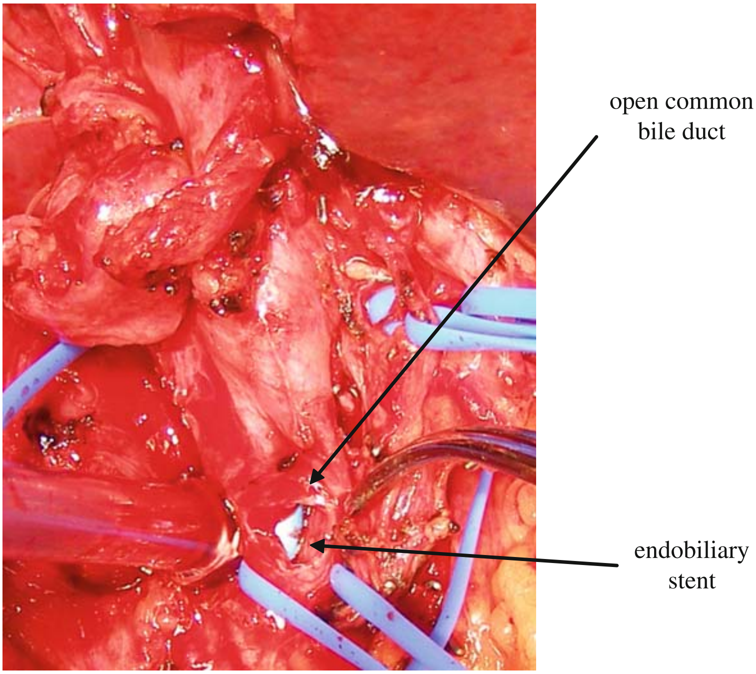


Fig. 33.20

The transected bile duct is elevated in a cephalad direction and portal lymphadenectomy is performed by sweeping all nodal tissues off the hepatic artery and portal vein toward the hepatic hilus (see Section 33.5).

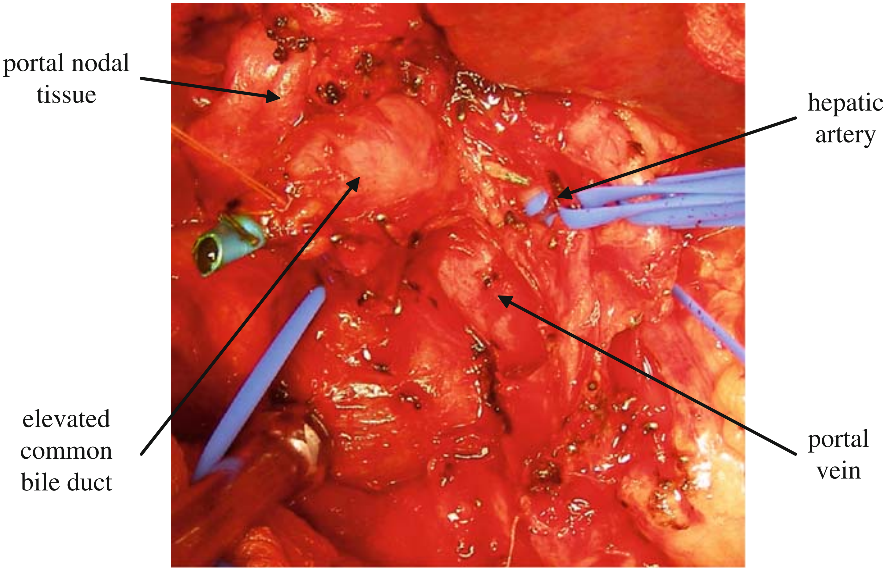


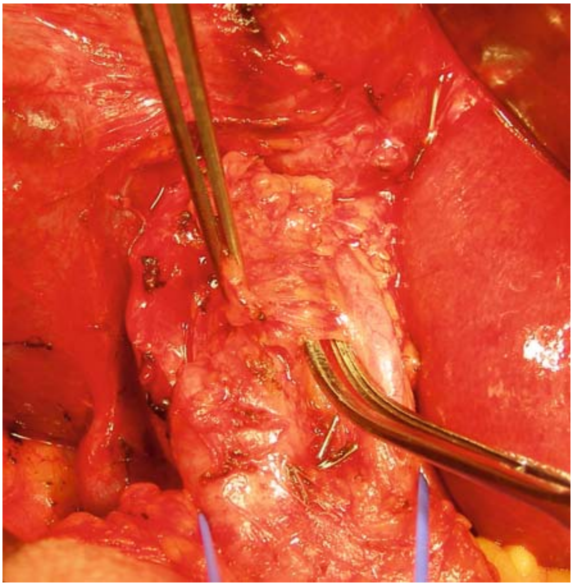
Fig. 33.21

The hepatic duct draining the planned liver remnant is transected above the level of the tumor and hepatic parenchymal transection is performed (see Right Hemihepatectomy or Left Hemihepatectomy).

33.5 Portal Lymphadenectomy

The peritoneum is incised to permit identification of the common bile duct.

Fig. 33.22



Nodal tissue is swept off the underlying porta hepatis structures from the duodenum to the hepatic hilus, with care taken to ligate all lymphovascular structures.

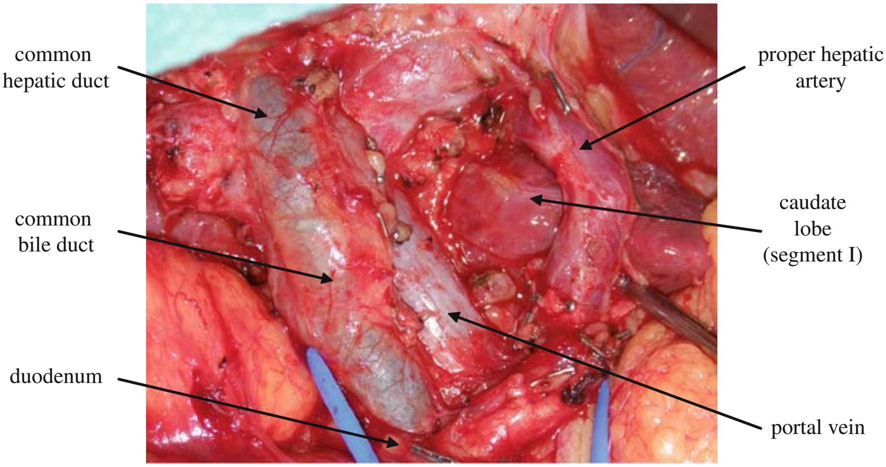


Fig. 33.23

33.6 Biliary-enteric Reconstruction

The cut hepatic duct is anastomosed to a small jejunotomy fashioned in a Roux-limb, which is delivered toward the liver through the transverse colonic mesentery.

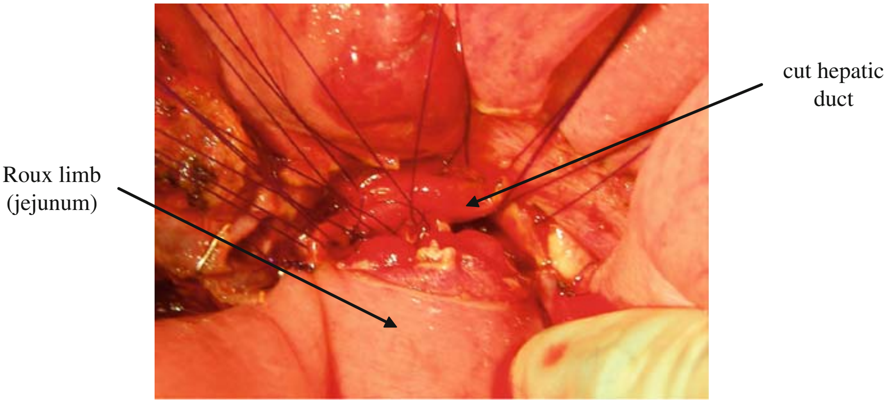


Fig. 33.24

Chapter 34
Laparoscopic Splenectomy

Andrew J. Russ and Clifford S. Cho

The lienocolic ligament and short gastric vessels are divided, permitting exposure of the inferior pole and hilus of the spleen.

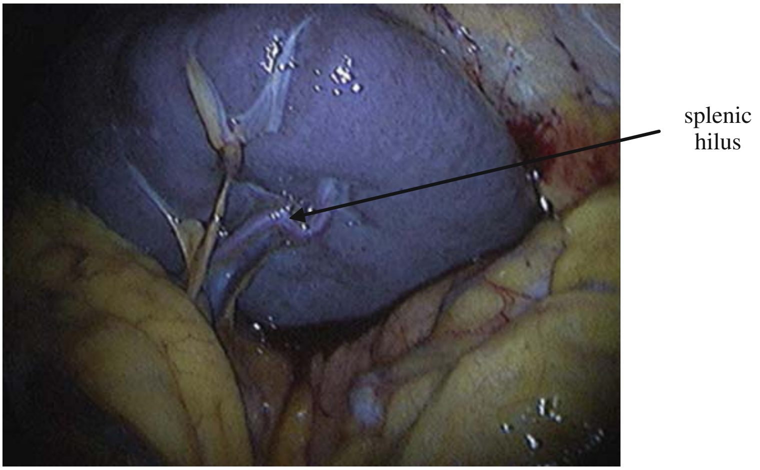


Fig. 34.1

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The posterior peritoneal and diaphragmatic attachments of the spleen are divided using a harmonic scalpel

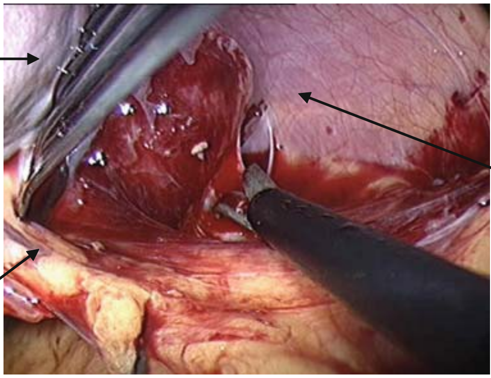


Fig. 34.2

The splenic hilus is transected with a linear stapler, with care taken to avoid injury to the pancreatic tail

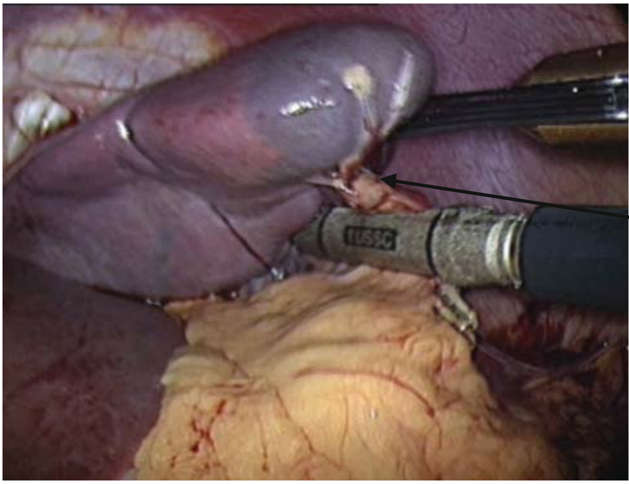
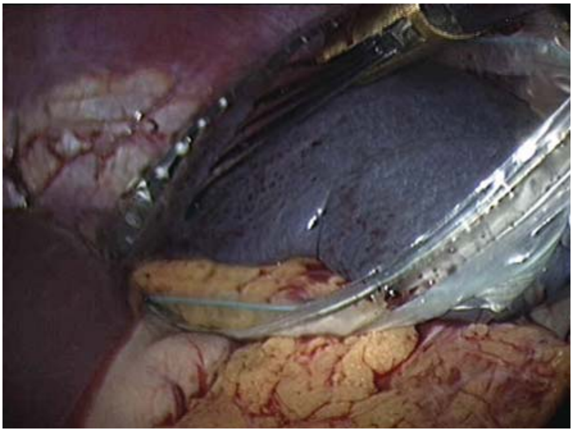


Fig. 34.3

The devascularized spleen is placed into a bag and removed

Fig. 34.4



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Part IX
Pancreatic Surgery

Section Editor: Sharon M. Weber

Chapter 35
Pancreaticoduodenectomy (Whipple Procedure)

Scott N. Pinchot and Sharon M. Weber

35.1 Indications

Carcinoma of the exocrine pancreas affects nearly 38,000 people in the United States each year and results in 35,000 deaths annually, making it the fifth leading cause of cancer-related death in this country each year [1]. Ductal adenocarcinoma and its variants account for 80–90% of all pancreatic neoplasms and for an even greater fraction of malignant pancreatic lesions. The remaining 10–20% of pancreatic neoplasms include other tumors of the exocrine pancreas (e.g., serous cystadenomas, mucinous cystadenomas), acinar cell cancers, and pancreatic neuroendocrine tumors (e.g., insulinomas, gastrinomas). As tumors of the head, neck, and uncinate process of the pancreas account for about 70% of pancreatic tumors, pancreaticoduodenectomy (PD), with or without preservation of the pylorus and proximal duodenum, remains the recommended treatment for patients with periampullary adenocarcinomas arising in the head of the pancreas, the ampulla, the distal common bile duct, or the duodenum. Recently, indications for PD have been extended to include intraductal papillary mucinous neoplasms arising in the head of the pancreas [2, 3] and periampullary tumors invading the mesenteric-portal vein [4, 5]. Nevertheless, PD continues to be an extensive operation with a postoperative mortality rate of less than 5% but a high morbidity rate of close to 40%, even in recent series [6, 7].

35.2 Perioperative Care

35.2.1 Preoperative Preparation

Preoperative cardiac clearance should be performed in all patients with a history of uncontrolled hypertension, coronary artery disease, previous coronary artery bypass

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grafting, or an abnormal preoperative electrocardiogram. Every attempt at normalizing electrolyte levels and renal function, as shown by creatinine and blood urea nitrogen, in the preoperative setting should be made. A Foley urinary catheter and nasogastric tube should be inserted to closely monitor fluid status. Administration of preoperative antibiotic prophylaxis is appropriate, as icteric patients and those patients receiving preoperative biliary drainage procedures have been shown to have higher rates of bacterial contamination of the bile and a higher rate of postoperative infectious complications following PD [8].

35.2.2 Positioning and Anesthesia

The patient is placed supine on a standard operating table. General anesthesia with endotracheal intubation is utilized.

35.3 Description of the Procedure

35.3.1 Pancreaticoduodenectomy (Whipple Procedure)

PD with hemigastrectomy (standard PD) has long been the standard approach to malignant neoplasms arising in the periampullary region. The operative procedure may be performed through either a bilateral subcostal or an upper abdominal midline incision. While the upper midline incision extending inferiorly below the umbilicus is useful, more extensive and free visualization of the upper abdomen may be afforded by the oblique or curved incision paralleling the costal margins. Regardless of the incision used, care must be taken to maintain meticulous hemostasis by carefully clamping and tying all bleeding points, especially in the jaundiced patient. After making the skin incision, the rectus muscles are slowly transected with bipolar electrocautery Fig. 35.1. Once the abdomen is entered, curved clamps may be utilized to assist ligation and division of the round ligament. Division of the falciform ligament superior to the dome of the liver may assist with further hepatic mobility.

Before irreversible steps are taken, a thorough exploration of the abdomen must be carried out to determine the location and extent of the pathologic process and to detect any evidence of tumor spread outside the limits of resection. The liver and all serosal surfaces should be carefully examined for metastatic spread or peritoneal dissemination. In addition, metastatic spread to the periportal and celiac axis lymph nodes, the root of the transverse mesocolon, the region above the pancreas, and the hepatoduodenal ligament should be sought by careful examination. The discovery of involved peripancreatic lymph nodes, even along the cephalad border of the pancreas near the portal vein, does not preclude resection, although it worsens prognosis [9]. Ultrasound may be helpful in ruling out metastatic spread to the liver.

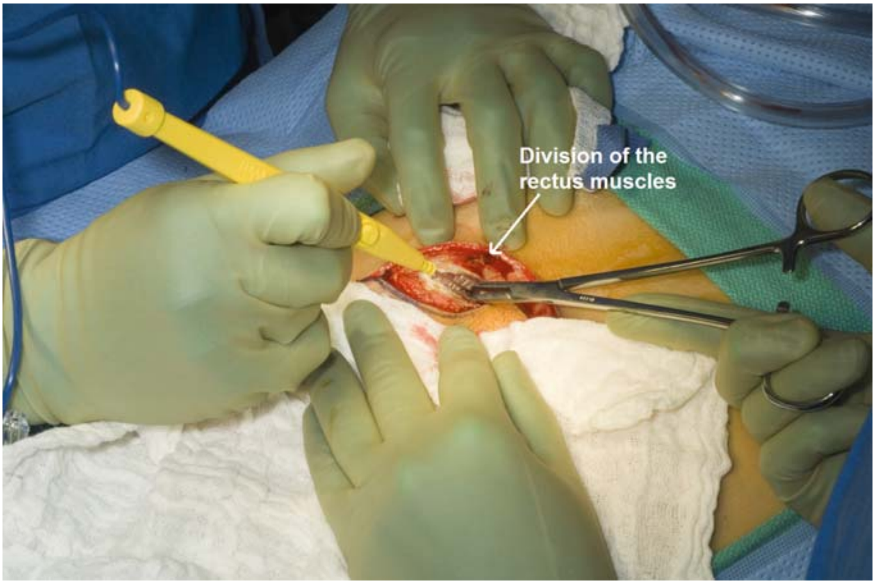

Fig. 35.1 Initial dissection for pancreaticoduodenectomy. A curvilinear, subcostal incision is first carried out over the right upper quadrant and is subsequently extended across the midline as far as is necessary for adequate surgical exposure. Excessive care must be taken to maintain meticulous hemostasis, especially in the jaundiced patient. After making the skin incision, the rectus muscles are carefully transected with bipolar electrocautery (shown above)

Once disseminated disease has been ruled out, the surgeon proceeds with mobilization of the duodenum and head of the pancreas by the Kocher maneuver. Dissection of the lateral peritoneal attachments of the duodenum, which facilitates inspection of the duodenum, head of the pancreas, and periampullary tumor is usually bloodless; an avascular cleavage plane can be easily developed as the posterior wall of the pancreas is bluntly separated from the underlying vena cava and right kidney. Extensive kocherization should be performed to allow the surgeon to be comfortable that there is no extension of tumor beyond the uncinate process. Special care should be taken to identify and preserve the right gonadal vein, which often runs parallel to the inferior vena cava at this point in the retroperitoneal dissection Fig. 35.2. Further mobilization of the second and third portion of the duodenum is carried out to adequately determine resectability of the lesion.

Before concluding that the lesion is resectable, the lesser sac must be entered to facilitate visualization and mobilization of the pancreas. The greater omentum is retracted upward and the gastrocolic ligament is incised all the way to the splenic flexure, allowing entry into the lesser sac. The right gastroepiploic artery and vein are identified and a thorough evaluation of potential metastases above the pancreas and adjacent to the celiac axis lymph nodes should be performed. The middle colic vein with its origin at the superior mesenteric vein should be identified and confirmed to be free of tumor involvement. The peritoneal attachments at the inferior

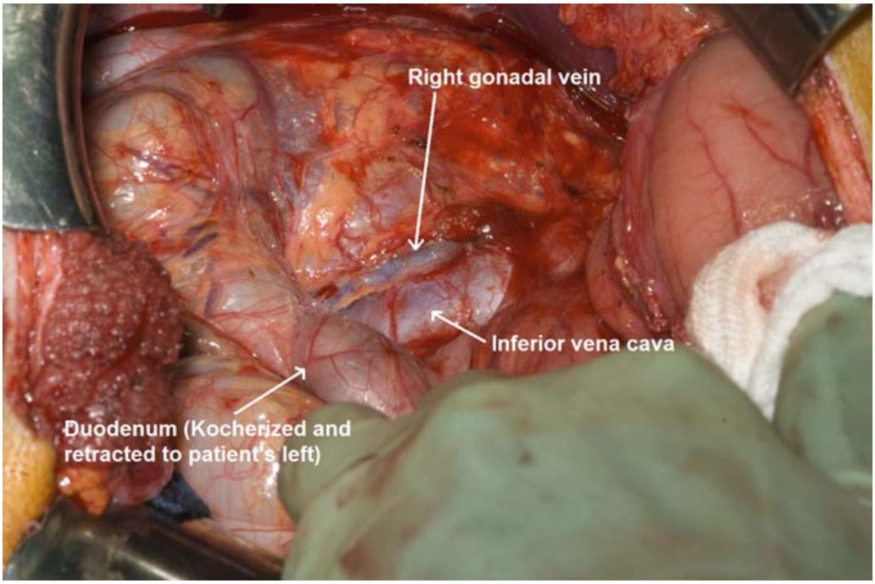

Fig. 35.2 Relationship of retroperitoneal structures encountered in the early stages of pancreaticoduodenectomy (Picture taken from patients leftside). Once disseminated disease has been ruled out, the surgeon may proceed with mobilization of the duodenum and head of the pancreas by the Kocher maneuver. With adequate duodenal mobilization, the surgeon should identify and preserve the right gonadal vein, which arises from and often runs parallel to the inferior vena cava at this point in the retroperitoneal dissection

border of the pancreas are incised and a cleavage plane over the superior mesenteric vein and behind the pancreas (the so-called "tunnel of love") is developed Fig. 35.3. Development of the subpancreatic tunnel will permit the surgeon to continue dissecting behind the pancreas and over the portal vein, to be certain it is not involved with tumor.

After the tumor is deemed resectable, irreversible steps can be taken. The gallbladder should be removed to prevent late complications from gallstone formation. Using electrocautery, the gallbladder is carefully dissected from the hepatic fossa. Meticulous hemostasis, especially in the jaundiced patient, should be maintained within the liver bed. The cystic artery is identified, doubly clipped, and transected. Dissection should continue to the common bile duct where it is encircled with a vessel loop for subsequent transection (Fig. 35.4). The surgeon then proceeds to ligate the blood supply necessary for antrectomy. The right gastric artery is identified, ligated with 2-0 silk sutures, and subsequently transected. Next, the gastroduodenal artery (GDA), passing inferiorly from the hepatic artery at the point where the portal vein passes posterior to the pancreas, should be suture ligated with 4-0 Prolene sutures. Just before ligating and dividing the GDA, the vessel should be occluded with a vessel loop or bulldog clamp to ensure adequacy of the hepatic artery pulse. At this point, important anatomic anomalies such as a replaced right hepatic artery

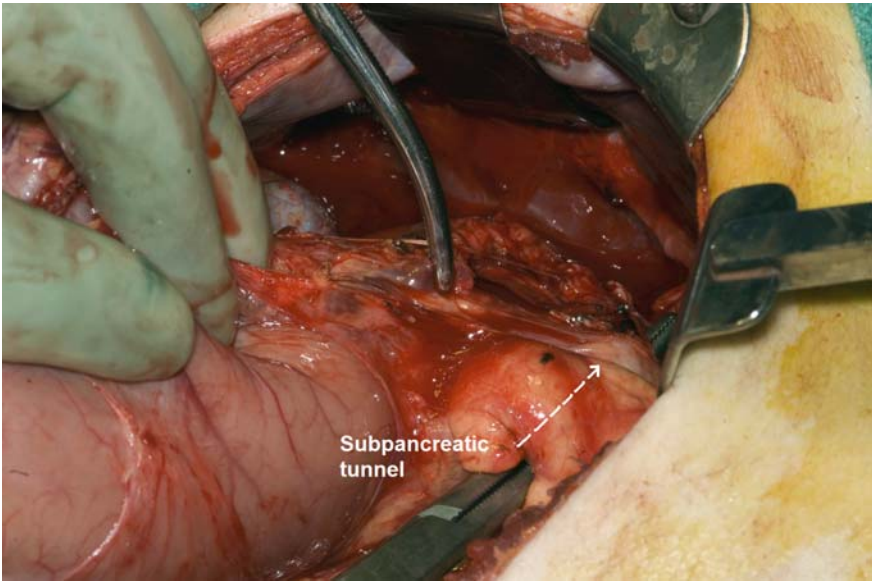

Fig. 35.3 Development of the subpancreatic tunnel. The peritoneal attachments at the inferior border of the pancreas are incised and a cleavage plane over the superior mesenteric vein and behind the pancreas (the so-called "tunnel of love") is developed. Development of the subpancreatic tunnel allows the surgeon to dissect posterior to the pancreatic neck and separate the tissues from the underlying portal vein. It is vital that the portal vein be identified at this portion of the case to be certain it is not involved with tumor. Note the clamp is behind the pancreas, over the SMV/PV

originating from the superior mesenteric artery (SMA) or a replaced common hepatic artery off the SMA, should be evaluated by palpating for an arterial pulse behind the common bile duct through the foramen of Winslow. Following this, the right gastroepiploic vessels are ligated and tied.

The removal of the antrum greatly assists in the subsequent exposure of the more difficult portion of the resection. After an area is cleared on both the greater and lesser curvature of the stomach, an antrectomy is performed using a GIA stapler. Once the stomach is transected, the remainder of the resection is carried out. The common hepatic duct is sharply transected just above the cystic duct. This not only allows the surgeon to perform a hepaticojejunostomy during the reconstructive phase of the procedure but also allows him or her to adequately visualize the portal vein. Attention is now directed toward mobilization of the upper jejunum. The transverse colon is flipped superiorly, allowing for adequate visualization of the jejunum and its mesentery. The upper jejunum may be grasped with Babcock forceps and the bowel held up in order to adequately visualize the vascular arcades supplying the jejunum. The ligament of Treitz, in its avascular plane, is taken down with cautery Fig. 35.5. Utilizing incisions made in the avascular portions of the mesentery, the jejunum is divided with a GIA stapler. The jejunal arcades are divided and ligated

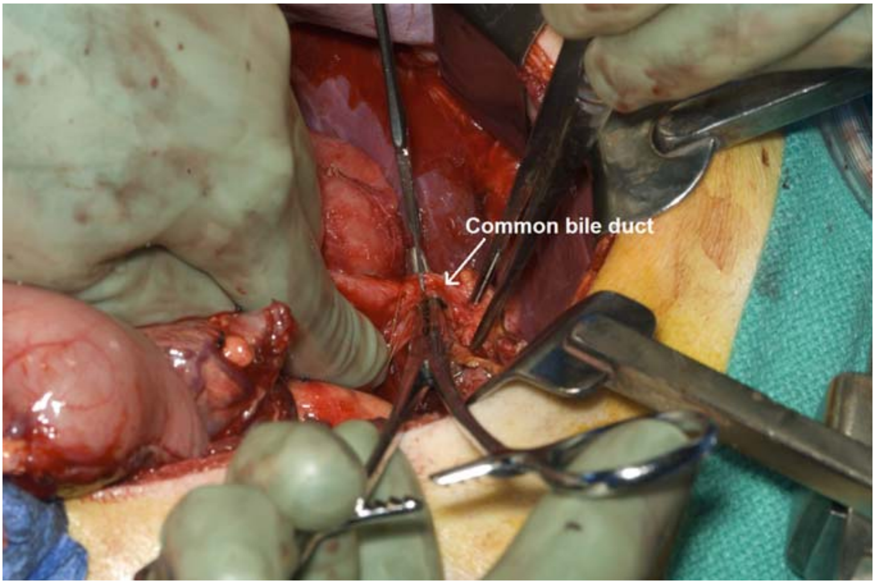

Fig. 35.4 Identification and division of the common bile duct. The gallbladder should be removed to prevent late complications from gallstone formation. Using electrocautery, the gallbladder is carefully dissected from the hepatic fossa. Meticulous hemostasis, especially in the jaundiced patient, should be maintained within the liver bed. The cystic artery is identified, doubly clipped, and transected. Dissection should continue down the common bile duct, transecting it above the cystic duct

to facilitate mobilization of the upper jejunum. A small opening is made in the mesocolon underneath the SMV and the mobilized upper jejunum is passed through the retrocolic window.

At this point, the only structure holding the specimen within the abdomen should be the pancreatic neck, which is now carefully divided. A surgical clamp may be carefully passed through the subpancreatic tunnel to protect the underlying portal vein and SMV while transecting the pancreas. Silk stay sutures are placed at the medial and lateral borders of the inferior and superior pancreas. Using a sharp scalpel, the pancreatic neck is divided Fig. 35.6. Sizable vessels may be encountered just above the pancreatic duct and care must be taken to ensure meticulous hemostasis. Alternatively, if the pancreatic duct has been occluded by tumor and the gland is fibrotic, this division may be relatively bloodless. Should excessive bleeding be encountered, suture ligation with a 3-0 Vicryl suture is usually adequate to gain control of the offending blood vessel. The SMV and portal veins are then bluntly dissected off the uncinate process Fig. 35.7. Often, the superior pancreaticoduodenal vein, draining into the portal vein, and the first jejunal vein branch are encountered and must be doubly ligated and divided in order to remove the surgical specimen.

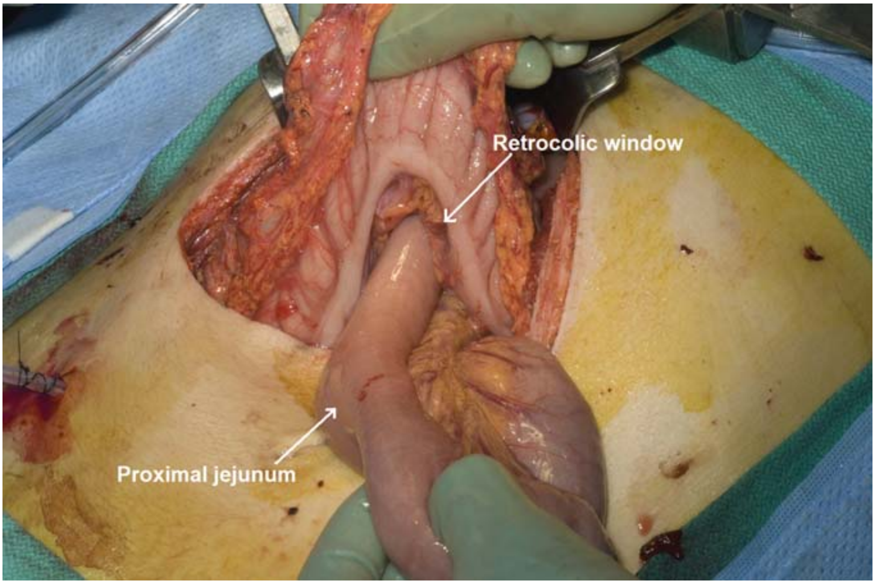

Fig. 35.5 Mobilization of the upper jejunum. With the transverse colon flipped superiorly, the jejunum and its mesentery is clearly visualized. Utilizing incisions made in the avascular portions of the mesentery, the jejunum is divided with a GIA stapler. The jejunal arcades are divided and doubly ligated to facilitate mobilization of the upper jejunum. A small opening is made in the retrocolic mesocolon and the mobilized upper jejunum is passed through the window

The specimen, consisting of the gastric antrum, duodenum, proximal jejunum, gallbladder and distal biliary tree, and pancreatic head are then passed from the surgical field.

Attention is now turned to reconstructing gastrointestinal continuity. The jejunum, which has been passed into the lesser sac through a retrocolic window, is allowed to lay in its usual fashion. The jejunal limb must be inspected to ensure adequate perfusion and the appropriate anastomotic sites for hepaticojejunostomy and pancreaticojejunostomy are identified. We typically perform the hepaticojejunostomy first, beginning with making a small enterotomy at least 5 cm distal to the proposed pancreaticojejunostomy site. The hepatic duct anastomosis is then carried out utilizing a single layer of 4-0 synthetic absorbable suture material placed in full-thickness fashion Fig. 35.8. Finally, the hepaticojejunostomy is inspected for leakage of biliary contents.

While the pancreaticojejunostomy may be performed in a variety of ways, all of which may be quite effective at reducing the incidence of pancreatic leaks, we prefer to invaginate the pancreatic remnant into the side of the jejunum using an outer layer and a duct-to-mucosa anastomosis of the pancreatic duct Fig. 35.9. This can be performed in many ways; the attached photographs document one technique for this anastomosis. Typically, we place a 10-French flat Jackson Pratt suction drain deep

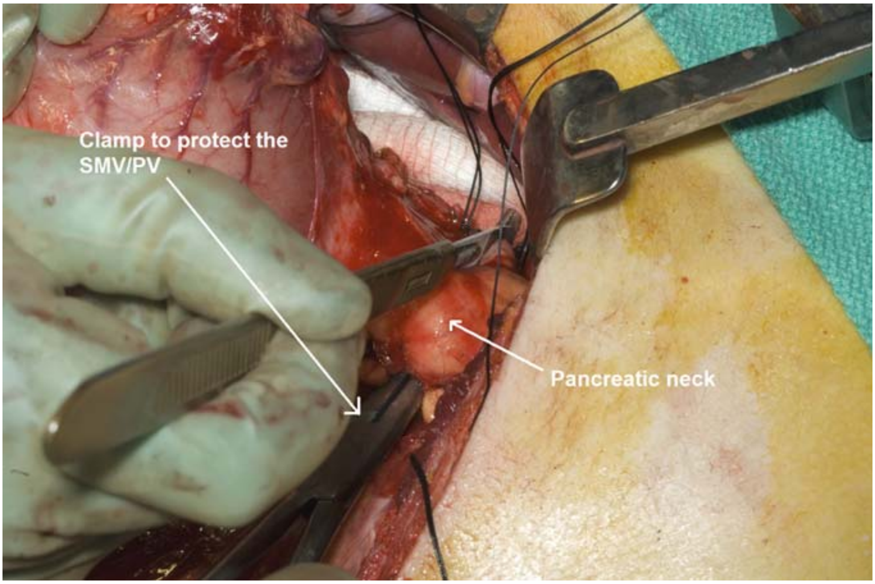

Fig. 35.6 Dividing the pancreas. A surgical clamp is carefully passed through the subpancreatic tunnel to protect the underlying portal vein and SMV while transecting the pancreas. Silk stay sutures are placed at the medial and lateral borders of the inferior and superior pancreas. Using a sharp scalpel, the pancreatic neck is divided. Sizable vessels may be encountered just above the pancreatic duct and care must be taken to ensure meticulous hemostasis

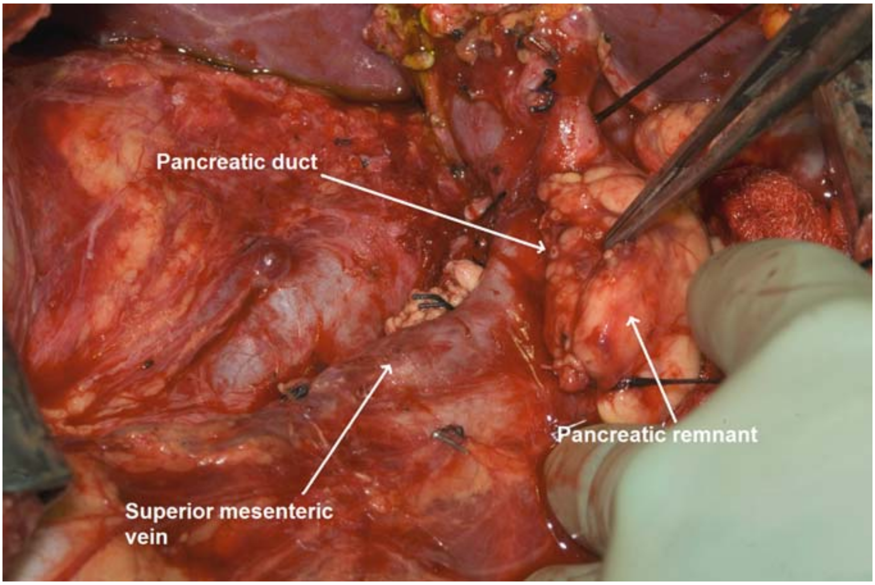

Fig. 35.7 Anatomic relationships following pancreaticoduodenectomy. Following transection of the pancreatic neck, the vascular structures deep to the proximal pancreas are evident

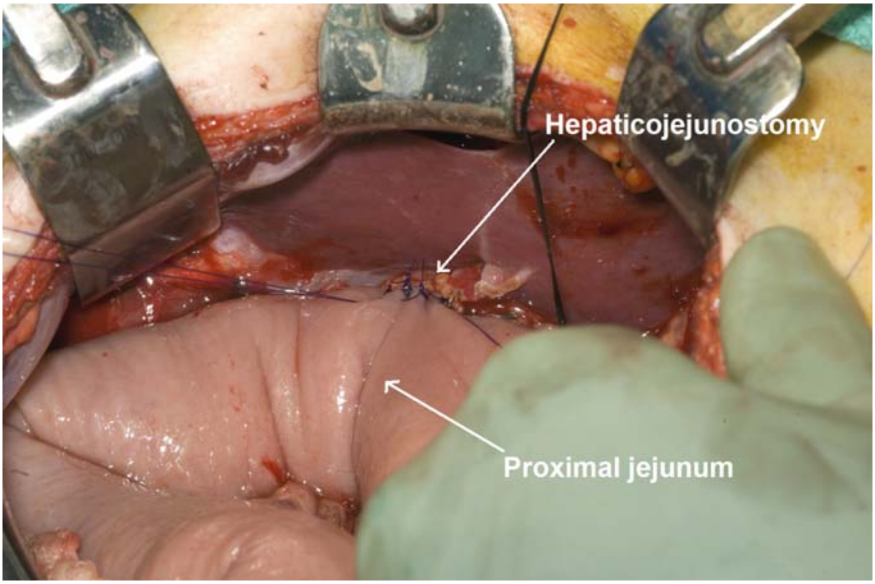

Fig. 35.8 Completing the hepaticojejunostomy. When restoring gastrointestinal continuity, we typically perform the hepaticojejunostomy first, beginning with making a small enterotomy at least 5 cm distal to the proposed pancreaticojejunostomy site. The hepatic duct anastomosis is completed utilizing a single layer of 4-0 synthetic absorbable suture material placed in full-thickness fashion. Finally, the hepaticojejunostomy is inspected leakage of biliary contents

to the pancreatic and biliary anastomoses to monitor for a pancreatic or biliary leak. The jejunum, at the point inwhich it traverses the transverse mesocolon (retrocolic), may be secured to the mesocolon with 3-0 Vicryl suture to prevent undue traction on the above anastomoses.

Lastly, attention is turned to the final anastomosis consisting of an end-to-side gastrojejunostomy Fig. 35.10. To begin, the antecolic gastrojejunostomy is performed with an outer interrupted layer of 3-0 PDS placed in Lembert fashion. Once the outer posterior row of sutures has been placed and secured, a portion of the gastric staple line is excised and an appropriately-sized gastrotomy is made. The inner layer on the posterior row is a continuous suture of 3-0 synthetic absorbable suture material, which is subsequently continued onto the anterior row. The gastrojejunostomy is completed with an outer layer of interrupted 3-0 silk sutures at the anterior margin of the anastomosis. The surgeon should assess for patency and perfusion of the anastomosis at this point in the procedure.

Finally, the abdomen is irrigated and thoroughly inspected for hemostasis. The nasogastric tube should be flushed and secured in the appropriate position. The fascia is closed with a running #1 PDS suture in two layers. After irrigating the wound, the skin should be closed with surgical staples and the wound covered with a sterile surgical dressing.

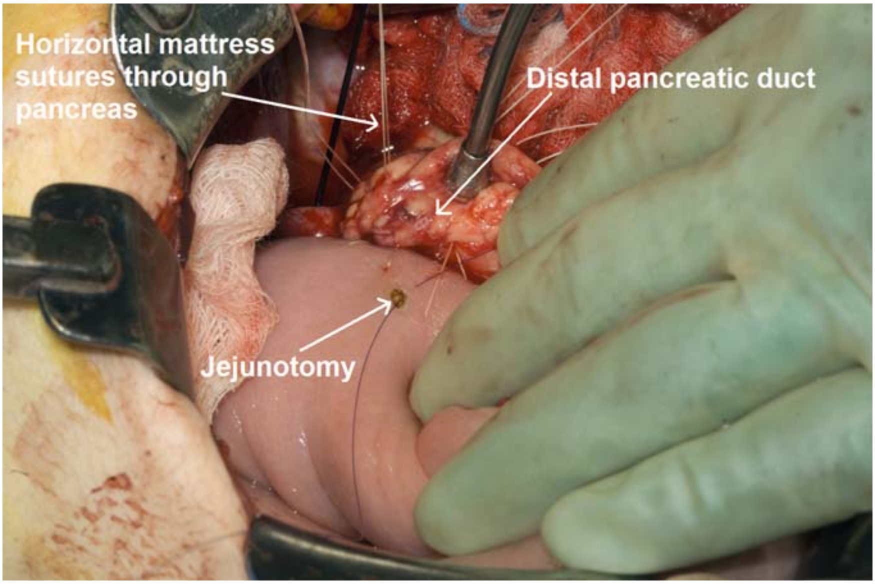

Fig. 35.9 Performing the pancreaticojejunostomy. We prefer to invaginate the pancreatic remnant into the side of the jejunum. The duct-to-mucosa anastomosis is begun by placing an outer interrupted layer of horizontal mattress 3-0 Vicryl sutures through the posterior surface of the pancreas and then through the jejunum. A jejunotomy of the same size and adjacent to the pancreatic duct is then made. Then, to achieve the duct-to-mucosa anastomosis, interrupted 5-0 synthetic absorbable suture material is used as a posterior row of sutures passing from inside out on the pancreatic duct and outside in on the jejunal mucasa are placed. Once the posterior sutures are placed and secured, the anterior row of duct-to-mucosa sutures is placed. The outer anterior layer is then completed an using the preplaced 3-0 Vicryl horizontal mattress sutures, thus invaginating the pancreatic remnant and completing the anastomosis

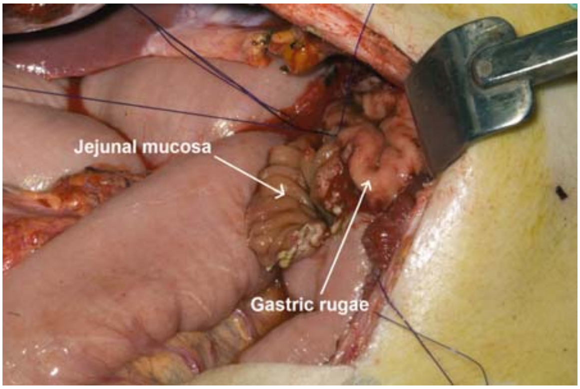

Fig. 35.10 Antecolic gastrojejunostomy. The end-to-side gastrojejunostomy is performed with an outer interrupted layer of 3-0 PDS placed in a Lembert fashion. Once the outer posterior row of sutures has been placed and secured, a portion of the gastric staple line is excised and an appropriately-sized gastrotomy is made. The inner layer on the posterior row is a continuous suture of 3-0 synthetic absorbable suture material, which is subsequently continued onto the anterior row. The gastrojejunostomy is completed with an outer layer of interrupted 3-0 silk sutures at the anterior margin of the anastomosis

35.4 Pylorus-Preserving Pancreaticoduodenectomy

The pylorus-preserving modification of the standard Whipple procedure has become the standard of care at many institutions. The procedure is nearly identical to PD with hemigastrectomy; however, in this variation the antrum and pylorus are spared. To do this, the right gastric artery is spared. Rather than performing an antrectomy, the duodenum is transected 2–3 cm distal to the pylorus and is later anastomosed to the jejunal limb. Most often, the pylorus-preserving PD procedure is chosen for patients with benign disease (commonly chronic pancreatitis of the pancreatic head and/or neck) and is thought to portend a better long-term nutritional outcome, although prospective randomized trials have shown no difference in outcomes between standard and pylorus-preserving PD.

35.5 Special Postoperative Considerations

Recent data have demonstrated rates of mortality of the order of 2–4% for PD in the hands of experienced surgeons; unfortunately, postoperative morbidity continues to be much more significant [6, 7]. Delayed gastric emptying (DGE), anastomotic breakdown, marginal ulceration, intraabdominal abscess or infection, pancreatitis, and pancreatic leaks remain the common complications after PD. Accounting for the highest proportion of morbidity (15–40%), delayed gastric emptying, while unpredictable, is thought to be related to the loss of motilin-secreting cells found throughout the duodenal mucosa. Anecdotal evidence supporting this theory is found in the favorable response rates seen in patients placed on erythromycin, an antibiotic with a similar structure to motilin. Though controversial, a recent meta-analysis suggests there is no difference in DGE for pylorus-preserving PD and classic pancreaticoduodenectomy [9]. Leakage from the pancreatic anastomosis is thought to occur in 15–20% of patients. External drainage of these fistulas will usually facilitate resolution of symptoms within several weeks.

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Chapter 36
Distal Pancreatectomy

Nicholas A. Hamilton and William G. Hawkins

36.1 Indications

Distal pancreatectomy is the surgical procedure indicated for any pathology in the body or tail of the pancreas, as defined by being left of the portal vein. Disease processes include benign and malignant neoplasms, both primary and metastatic to the pancreas [1], pancreatic cysts [2], pseudocysts, or strictures from pancreatitis that have not spontaneously resolved [3] and benign inflammatory conditions. Patients sustaining a traumatic injury to the body or tail of the pancreas with suspicion or direct evidence of pancreatic duct disruption also should undergo a distal pancreatectomy [4].

Unlike diseases of the head or neck of the pancreas, diseases in the body or tail of the pancreas do not generally lead to jaundice, as they do not cause biliary obstruction. Symptoms usually include vague abdominal pain, weight loss, nausea, and early satiety. Rarely patients with neuroendocrine tumors may have symptoms such as dizziness, headaches, and palpitations as a result of hormonal activity.

36.2 Preoperative Preparation: Imaging Studies

Lesions requiring a distal pancreatectomy are usually found on computed tomographic (CT) imaging during the diagnostic process. Ultimately, a 3-phase fine-cut helical CT scan should be performed, especially in the case of suspected malignancy. Cystic [5] and solid lesions alike are amenable to biopsy during an endoscopic ultrasound, which can be performed both for tissue diagnosis as well as evaluation of locally advanced disease in the case of malignant tumors. In the case of pancreas adenocarcinoma, it is important to determine the extent of the disease, as patients with evidence of advanced regional disease or metastatic disease are not candidates for surgical resection. We recommend a bowel preparation, as a portion of the transverse colon may, on occasion, need to be resected.

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36.3 Positioning and Anesthesia

Patients undergoing a distal pancreatectomy are most commonly placed in a supine position with their arms extended. General anesthesia is required. At the end of a laparoscopic distal pancreatectomy, local anesthesia is injected around the port sites for pain control in the initial postoperative period. The abdomen is prepped and draped from the nipples to the pubic symphysis.

36.4 Description of Procedure

The surgical technique for benign or premalignant pancreatic disease differs from that for malignant disease. For benign disease of the pancreatic body and tail, the resection approach can be from the spleen towards the body and neck of the pancreas (retrograde) or starting at the neck of the pancreas and working towards the tail (antegrade). In order to maximize the lymphatic dissection and improve the chance for a margin negative resection our group recommends that an antegrade resection should be performed when pancreatic cancer is suspected or proven [6].

36.4.1 Open Distal Pancreatectomy (RAMPS Procedure)

A staging laparoscopy is performed to rule out any peritoneal or liver metastases. Once it has been determined that there is no evidence of metastatic disease, a long, oblique, left upper quadrant incision that extends over the midline to the right and also vertically in the midline is made (a midline incision is an acceptable alternative, and may be preferable in thin patients). The greater omentum is dissected off of the colon using electrocautery and the short gastric vessels are divided close to the stomach using an ultrasonic or bipolar sealing device. Alternatively, the short gastric vessels can be individually clipped or ligated. The neck of the pancreas is then visualized by retracting the stomach superiorly. The pancreas is gently elevated off the superior mesenteric and portal veins inferiorly and superiorly. Dissection along the superior edge of the neck of the pancreas will reveal the common hepatic artery, which can be traced rightward to the gastroduodenal artery and leftward to the celiac confluence and identification of the splenic artery. The lymph nodes on the left border of the proper hepatic artery and portal vein as well as those anterior to the common hepatic artery are mobilized. The anterior surface of the portal vein is exposed by retracting the gastroduodenal artery to the right and the tunnel behind the neck of the pancreas is completed. The neck of the pancreas is then divided. We prefer a linear GIA stapler with a thick tissue load. This may be oversewn with interlocking figure of eight sutures. The celiac nodes are next dissected free by dividing the coronary vein near the lesser curve of the stomach and then dividing the peritoneum at the base of the caudate lobe, sweeping the fat and nodes inferiorly off the crus of the diaphragm. The fat and nodes anterior to the hepatic artery are then swept medially and the coronary vein is again divided, this time at the portal vein.

The origin of the splenic artery from the inferior aspect of the celiac artery can now be seen and it is ligated near its origin. The splenic vein is next isolated at its junction with the superior mesenteric vein and divided. The dissection now proceeds vertically until the superior mesenteric artery is encountered. The artery is followed posteriorly and superiorly on its left side to the aorta. The lymph nodes anterior to the aorta between the celiac artery and superior mesenteric artery and those anterior to the left of the superior mesenteric artery are taken. If preoperative imaging suggests posterior invasion the dissection can easily be extended posteriorly to include the adrenal gland superiorly and Gerota's fascia inferiorly. The superior and inferior attachments of the pancreas are divided as the dissection proceeds to the left and the inferior mesenteric vein is ligated and transected and the lienorenal ligament is divided. Once the lienorenal ligament is divided, the specimen is removed *en bloc*. The abdomen is irrigated and hemostasis is obtained. A drain is placed in the resection bed, exiting the skin in the left upper quadrant. The incision is closed using number 1 Prolene sutures in a running fashion starting laterally and tied to each other medially. The skin is closed with staples and a sterile dressing is applied [6].

36.4.2 Laparoscopic Distal Pancreatectomy

An infraumbilical incision is made and a 10-12-mm trocar is inserted. The abdomen is insufflated and the following additional trocars are placed in the upper abdomen; one 5-mm and one 10-mm port just to the right of midline and 2 5-mm ports in the left upper abdomen. A four-quadrant examination of the abdomen is undertaken, paying particular attention to any nodules or irregularities of the liver or the peritoneum. The stomach is mobilized from the transverse mesocolon and the lesser sac is entered (Fig. 36.1). The splenic flexure of the colon is mobilized using the ultrasonic dissector or 5-mm ligaSure. This can be aided by tilting the operating

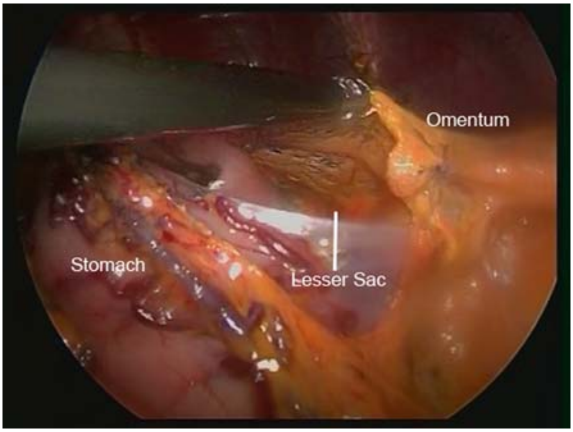

Fig. 36.1 Entering the lesser sac

table so the patient's left side is elevated 30–45°. This is carried towards the inferior margin of the spleen. If the spleen is to be removed, all short gastric arteries to it are taken down with the ultrasonic dissector or with hemoclips (Fig. 36.2). The dissection then proceeds toward the gastroesophageal junction, making sure to stay on the inferior aspect of the gastroepiploic vessels. Filmy attachments between the pancreas and the posterior stomach are dissected (Fig. 36.3). A fixed retractor is utilized to elevate the stomach and left liver anteriorly and cephalad to expose the entire length of the pancreas. The superior aspect of the pancreas is then mobilized toward the portal vein along the hepatic artery. The hepatic artery is then traced back to the confluence of the celiac artery and the left gastric artery. The inferior aspect of the pancreas is next mobilized toward the spleen (Figs. 36.4 and 36.5). If the spleen is to be preserved, the splenic vein is dissected free of the posterior pancreas. Hemostasis is achieved with the ultrasonic dissector and the application of hemoclips. The pancreas is elevated superiorly to allow for retroperitoneal pancreatic access and a tunnel is then created underneath the pancreas to expose the portal vein. The pancreas is then transected using an endo GIA stapler (Figs. 36.6 and 36.7). The staple line can be reinforced by using buttress material, as seen in the figures. The use of buttress material to reinforce the staple line may or may not reduce the postoperative fistula rate [7]. The splenic artery is identified (Fig. 36.8) and stapled with a vascular load of a GIA Endo stapler if it is to be removed. The

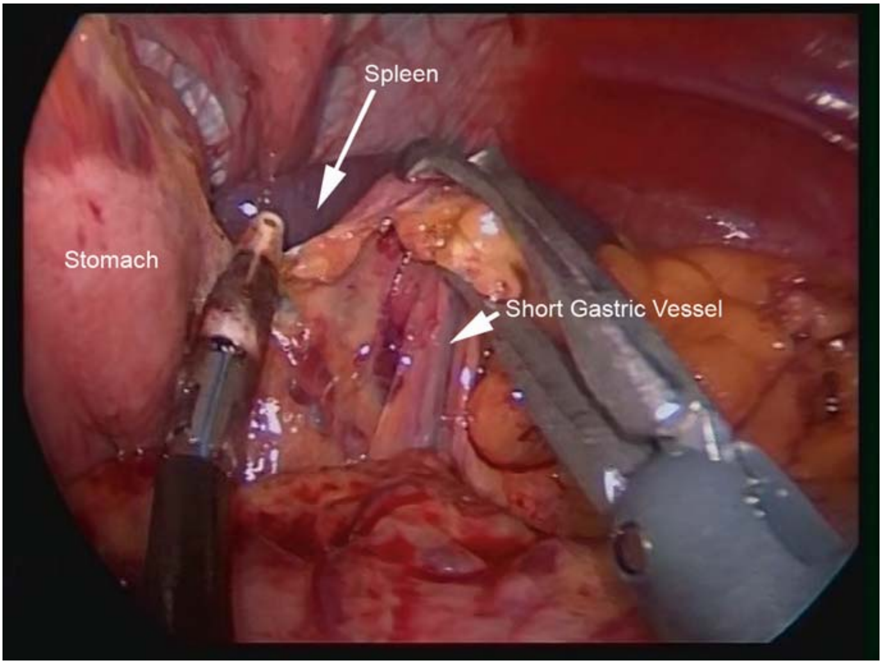

Fig. 36.2 Taking down the short gastric vessels

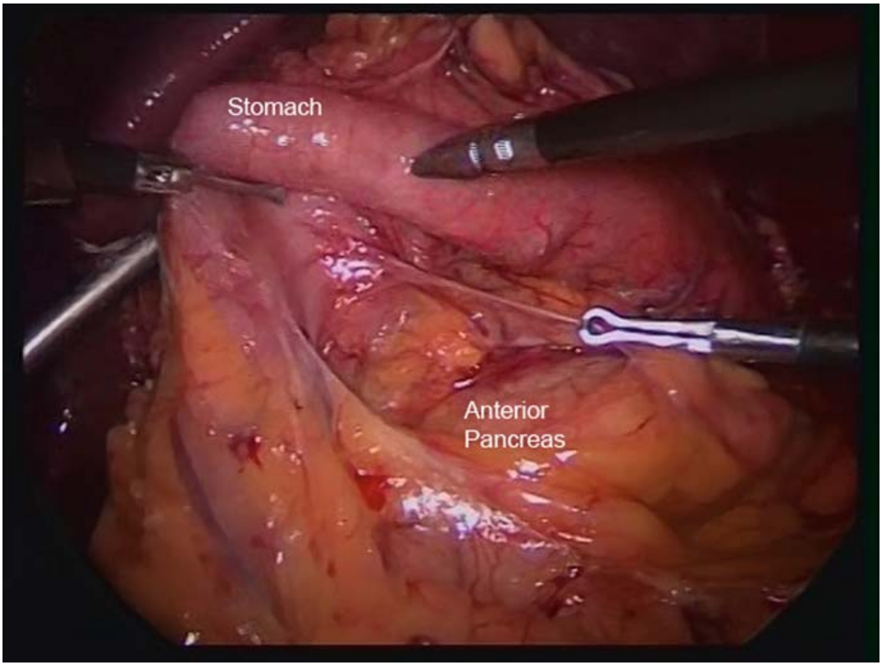

Fig. 36.3 Exposing the anterior pancreas

portal–splenic confluence is identified by retracting the resected pancreas laterally (Fig. 36.9). The splenic vein is then stapled here (Fig. 36.10), if the spleen is to be removed. The specimen is placed into a specimen bag (Fig. 36.11). The upper midline port incision is extended and the specimen is delivered from the small upper midline incision (Fig. 36.12). Hemostasis is assured and a drain is placed at the pancreatic transection line, coming out of the left upper quadrant. The trocar sites and the specimen extraction sites are closed with absorbable sutures and the skin is closed with a subcuticular monofilament suture and a sterile dressing is applied.

36.5 Postoperative Care

The complication rate following distal pancreatectomy is approximately 30%. The most common complications encountered are pancreatic leak or fistula (5–29%) [8, 9], new-onset insulin-dependent diabetes (9%) [9], intraabdominal abscess (4%), small bowel obstruction (4%), and postoperative hemorrhage (4%) [8]. Postoperative care is targeted to avoid or minimize these complications.

Postoperatively uncomplicated patients are admitted to a general ward for 2–3 days. Perioperative pain may be managed by intravenous narcotics or epidural catheters. One of the most critical aspects of their recovery is the diligent use

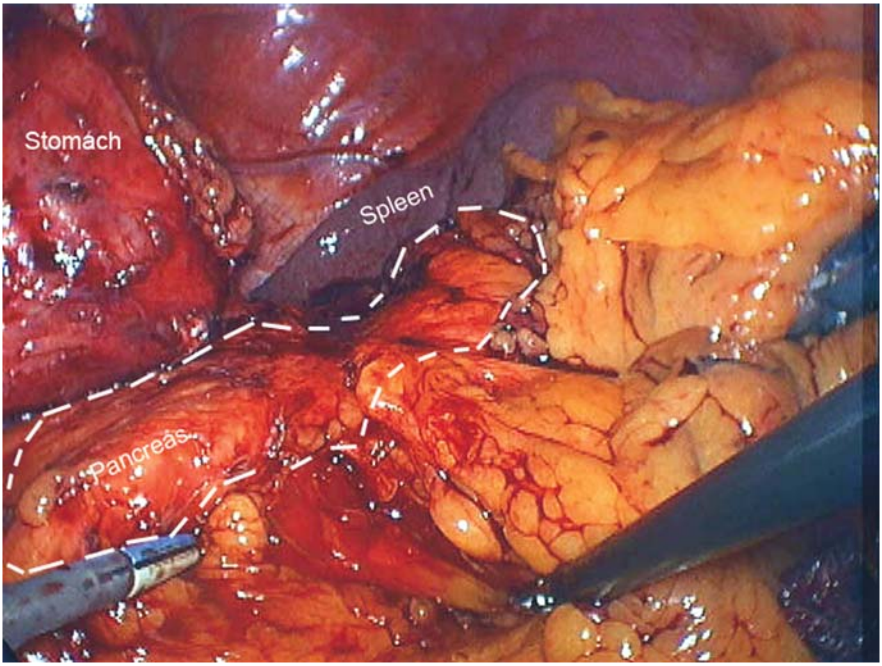

Fig. 36.4 The pancreas in situ

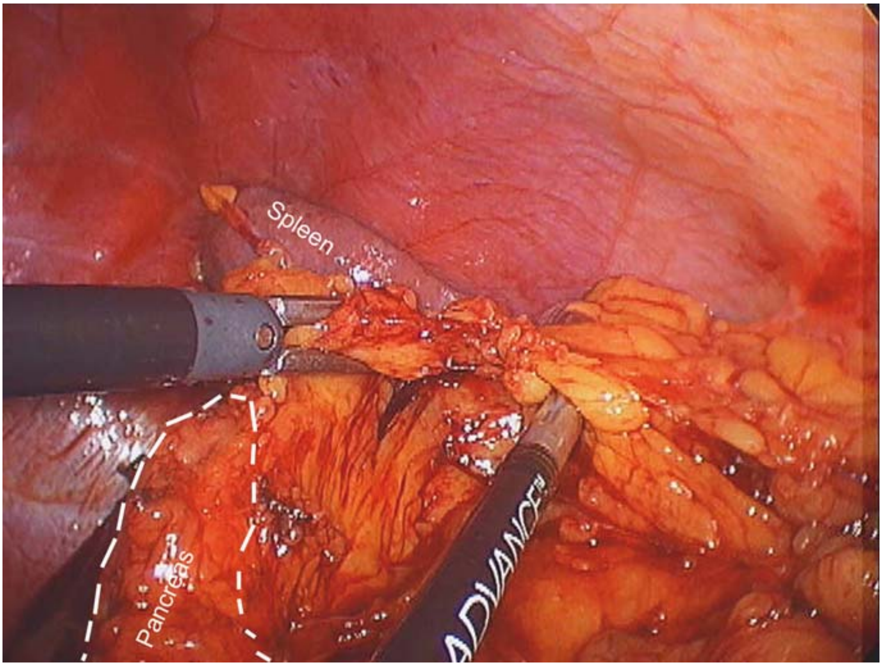

Fig. 36.5 Mobilizing the inferior pancreas near the spleen

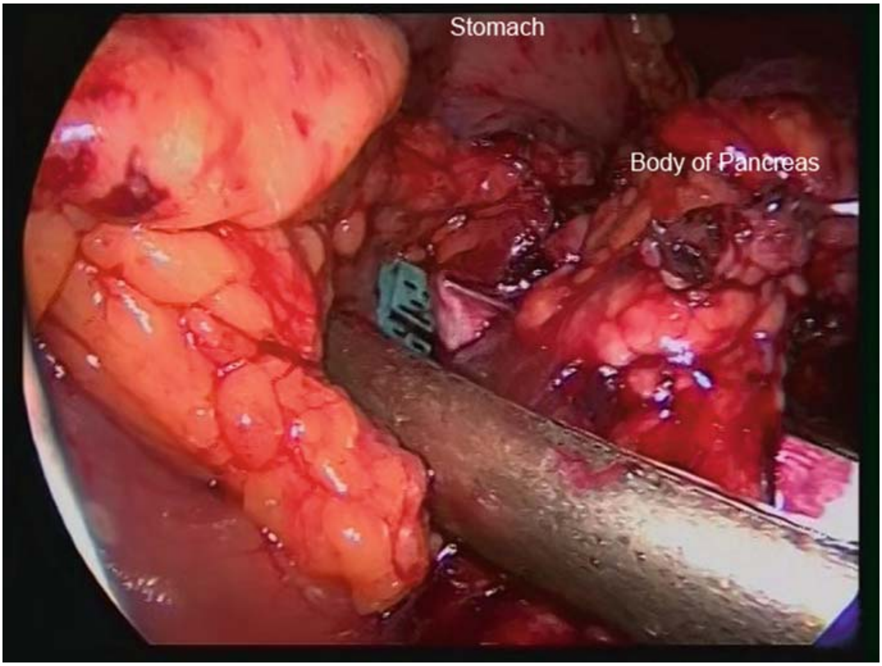

Fig. 36.6 Stapling across the pancreas

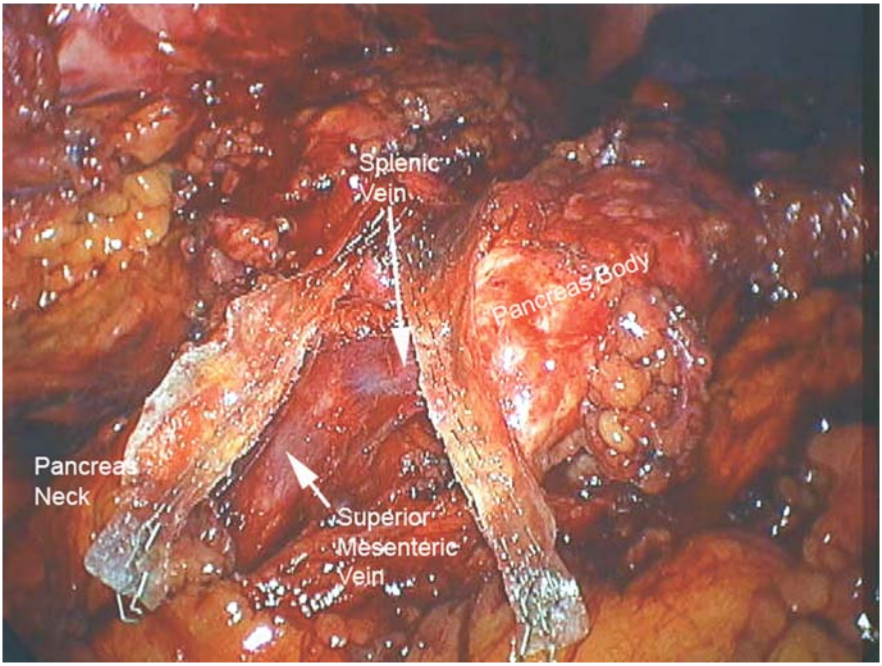

Fig. 36.7 The transected pancreas

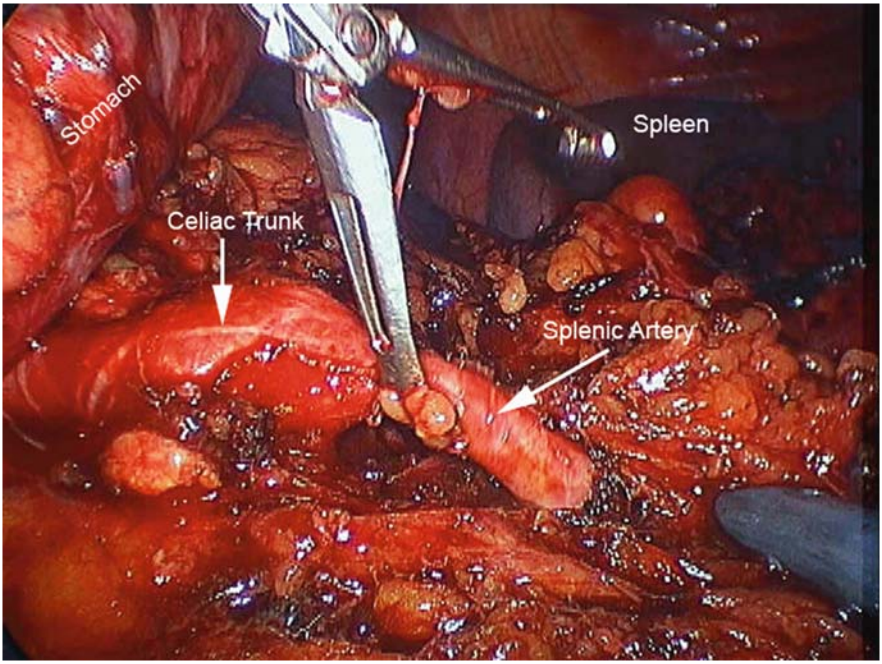

Fig. 36.8 Identification of the splenic artery

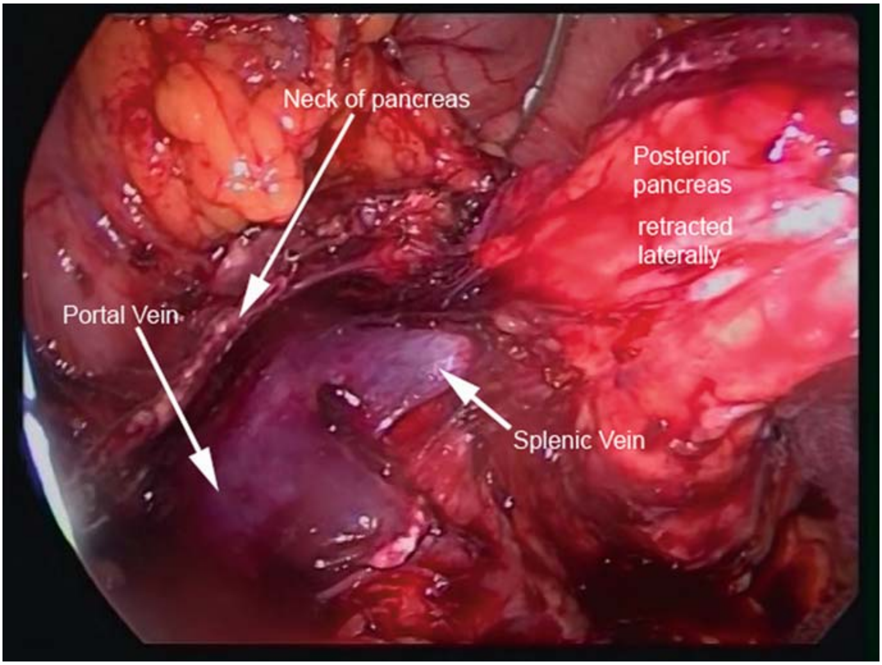

Fig. 36.9 Portosplenic confluence exposed

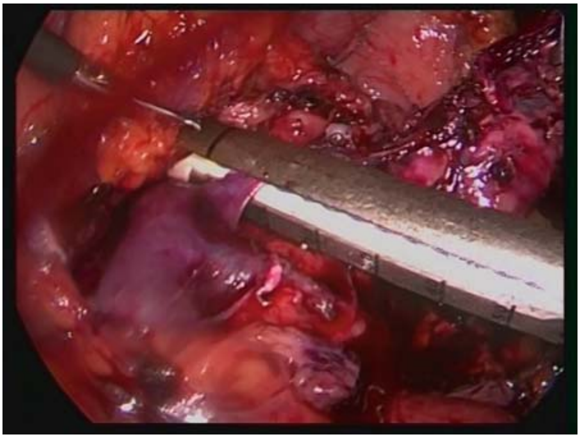

Fig. 36.10 Dividing the splenic vein

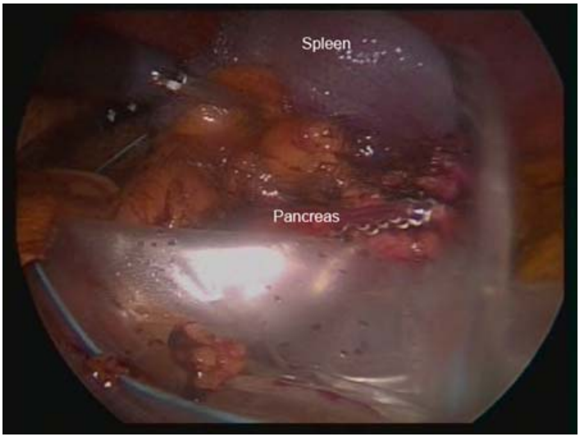

Fig. 36.11 The final specimen in the specimen bag

of an incentive spirometer to encourage deep breathing and to prevent atelectasis and pneumonia. It is also important to routinely monitor blood glucose levels, as removing part of the pancreas can make a patient either temporarily or permanently diabetic [10]. Another aspect of patient management that should not be overlooked is adequate venous thrombosis prophylaxis, particularly in patients with malignancies. Patients should be encouraged to ambulate as soon and as often as possible. The Foley catheter is discontinued once the patient demonstrates that they are adequately volume resuscitated. In most patients the nasogastric tube is discontinued on postoperative day 1. The diet is advanced from clear liquids to a regular diet as tolerated by the patient. When an oral diet is resumed, medications are changed from intravenous to oral. If there is a change in the abdominal drain output, volume or quality, drain fluid amylase and lipase are sent in conjunction with a patient's serum amylase and lipase. If the drain amylase or lipase is greater than three times

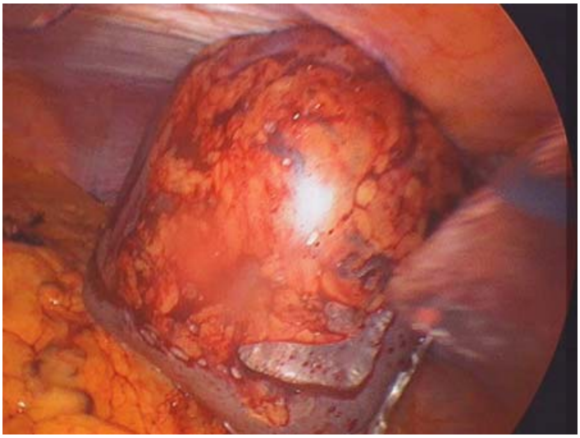

Fig. 36.12 The specimen being removed

that of the serum, the patient has a pancreatic leak and is discharged home with the drain in place. When the patient demonstrates the ability to maintain an oral intake to keep himself adequately hydrated and has significant pain control on oral pain medication, he may be discharged from the hospital. Patients are seen back in the surgeon's clinic in 2 weeks for a routine postoperative visit. If there was a leak at the time of discharge, the drain fluid is again analyzed and may be removed if it has normalized.

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Chapter 37
Surgical Treatment of Chronic Pancreatitis

Matthew R. Porembka, William G. Hawkins, and Steven M. Strasberg

37.1 Background

Chronic pancreatitis is characterized by progressive parenchymal fibrosis resulting in loss of pancreatic exocrine and endocrine function. The pathogenesis of chronic pancreatitis is unclear, but is thought to be secondary to repeated parenchymal injury. Common etiologies include alcoholic pancreatitis, autoimmune pancreatitis, and pancreatic duct obstruction caused by pancreatic divisum or stricture. The disease affects all elements of the gland; exocrine dysfunction can occur early in the disease process followed by subsequent endocrine dysfunction. Parenchymal fibrosis often causes pancreatic duct strictures resulting in distal pancreatic duct dilation. Intraparenchymal calcification and intraductal calcium calculi are common.

The presentation of chronic pancreatitis is variable, however, patients most commonly present with severe, recurrent abdominal pain. Although several mechanisms have attempted to explain how chronic pancreatitis causes abdominal pain, the exact etiology remains unknown [1].

The treatment of chronic pancreatitis can be difficult and requires multidisciplinary treatment by general practitioners, gastroenterologists, radiologists, and surgeons. Initial treatment is nonoperative and includes pain control with oral analgesics. Frequently, patients require escalation to narcotic pain medicines and referral to pain management specialists. Endoscopic treatments aimed at reliving the chronic pain associated with chronic pancreatitis have been developed and include celiac axis block, pancreatic sphincterotomy, and pancreatic duct stenting. The published results of these interventions have demonstrated varying efficacy and durability [2, 3, 15]; their discussion is beyond the scope of this chapter.

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37.2 Indications for Surgical Therapy

Although initial treatment of chronic pancreatitis is nonoperative, the indications which require surgical treatment are listed in Table 37.1. The most frequent indication for surgery in patients with chronic pancreatitis is intractable pain.

Table 37.1 Indications for surgery in chronic pancreatitis

Pain refractory to medical therapy
Recurrent pancreatitis secondary to pancreatic duct stenosis
Bile duct stenosis
Gastric outlet obstruction/duodenal obstruction/colonic obstruction
Pancreatic fistula
Pseudocyst
Pancreatic carcinoma

37.3 Preoperative Preparation

37.3.1 Preoperative Workup

Just as in all major intraabdominal surgeries, thorough preoperative cardiac risk evaluation should be carried out [5]. In addition, patients with chronic pancreatitis should be screened for ongoing alcohol abuse and referred to a treatment program, if necessary, before undergoing elective resection. In a recent review, 20% of patients undergoing surgery for chronic pancreatitis retrospectively reported active alcohol abuse at the time of surgery [10].

In cases in which sequelae of chronic pancreatitis have resulted in severe malnutrition (albumin <2), consideration should be given to nutrition supplementation. Enteral feeding is preferable to total parenteral nutrition [9]. Pancreatic enzyme therapy is often required for adequate digestion of food. All patients should receive a bowel regimen such as magnesium citrate the night before surgery to facilitate the creation of a Roux loop, if necessary.

37.3.2 Imaging Studies

Imaging studies are crucial for fully evaluating the extent of disease and for surgical planning. It provides confirmation of chronic pancreatitis, assessment of pancreatic duct diameter, definition of pancreatic anatomy, and the determination of associated disease or malignancy.

Triple-phase contrast-enhanced, fine-cut, computed tomography is the preferred modality for the evaluation of chronic pancreatitis. The sensitivity of CT scan is almost 100% for diagnosing advanced disease and readily detects the common

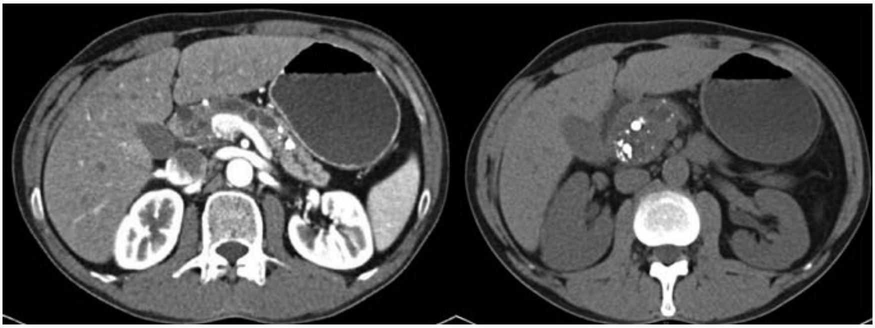

Fig. 37.1 Preoperative CT scan demonstrating dilated pancreatic duct on contrast scan and severely calcified and diseased pancreatic head on non-contrast images

sequelae of pancreatitis including the presence of an inflammatory mass, pancreatic pseudocyst, bile duct stricture, pancreatic ductal dilation, and gastric outlet obstruction (Fig. 37.1). In patients with an inflammatory mass, it is crucial to rule out pancreatic adenocarcinoma. If the diagnosis is unclear on axial imaging, additional studies may be required to completely evaluate the patient. Endoscopic retrograde cholangiopancreatogram (ERCP), endoscopic ultrasound (EUS) with biopsy, magnetic resonance imaging (MRI), and magnetic resonance cholangiopancreatogram (MRCP) can provide valuable information in difficult cases. Definitive oncologic resection is indicated if the presence of malignancy is suspected and cannot be ruled out.

ERCP is the gold standard for examination of pancreatic ductal anatomy. In chronic pancreatitis, the pancreatic duct displays an irregular contour with multifocal strictures, dilatations, and stones. MRCP provides similar images without the invasiveness of an endoscopy, but is less precise. EUS easily defines pancreatic anatomic relationships and allows for non-invasive tissue sampling under ultrasound guidance [13].

37.3.3 Procedure Selection

The choice of operation is dependent on pancreatic ductal anatomy and the extent of disease throughout the gland. Operations to palliate abdominal pain either (1) drain a dilated pancreatic ductal system or (2) resect diseased pancreatic parenchyma in cases in which the duct is of normal diameter. The main pancreatic duct normally measures 4–5 mm in the head of the pancreas and gently tapers throughout the body (3–4 mm) and tail (2–3 mm).

Patients with a dilated main pancreatic duct (>7 mm in the body of the gland) are best treated with procedures to decompress and drain the dilated duct (longitudinal pancreaticojejunostomy – Puestow procedure, or longitudinal pancreaticojejunostomy with coring of the head – Frey procedure). On the other hand, patients with a diseased gland and normal pancreatic duct diameter may require resection

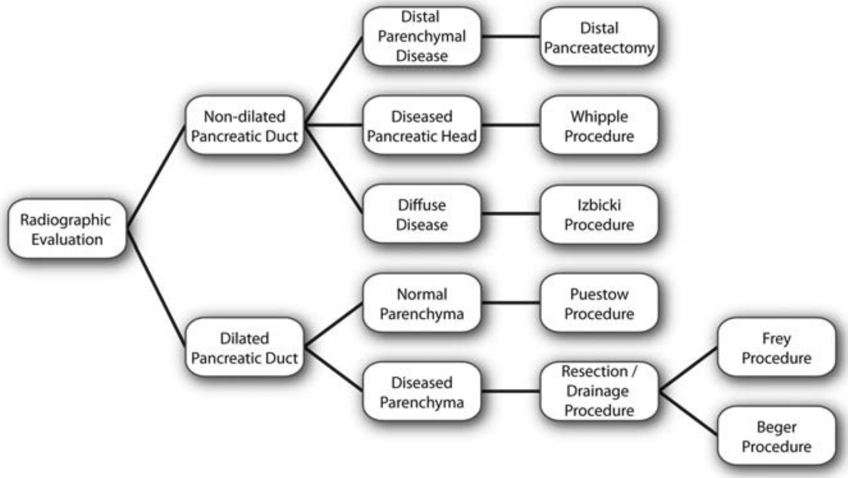

Fig. 37.2 Treatment algorithm for the surgical management of chronic pancreatitis

of the diseased gland. The choice of resection (distal pancreatectomy, pancreaticoduodenectomy, Beger procedure, Izbicki procedure) is dependent on surgeon's preference and the anatomical extent of disease. Some of these operations (Frey, Beger, Izbicki) have elements of resection and drainage (Fig. 37.2).

37.4 Surgical Procedures for Chronic Pancreatitis

37.4.1 Drainage Procedures

Longitudinal pancreaticojejunostomy (Puestow procedure) is performed for the drainage and decompression of a dilated pancreatic duct. Despite providing temporary pain relief, the procedure is associated with approximately 50% of patients developing recurrent abdominal pain within 5 years. Failure is due to the fact that the procedure may inadequately decompress ducts in the head and uncinate process.

37.4.2 Resection for Chronic Pancreatitis

Patients with parenchymal disease and a normal diameter or narrowed pancreatic duct are candidates for pancreatic resection. The extent of resection is dependent upon the location and extent of disease. Pancreaticoduodenectomy (Whipple resection) may be indicated in patients with an enlarged pancreatic head, containing multiple cysts or calcifications. Distal pancreatectomy is indicated in patients with a normal pancreatic duct and disease confined to the distal gland. However, resection

is associated with an increased incidence of postoperative endocrine and exocrine dysfunction.

37.4.3 Combined Resection and Drainage Procedures

Procedures that involve limited pancreatic resection and pancreatic duct drainage attempt to provide permanent pain relief, while avoiding exocrine and endocrine dysfunction. Variations exist based on the method of pancreatic head resection. The Frey procedure combines limited resection by coring of the pancreatic head with unroofing of the dilated pancreatic duct and lateral pancreaticojejunostomy. The Beger procedure is a duodenal-sparing resection of the pancreatic head; drainage is accomplished through a Roux limb to the periampullary pancreas and the remaining tail, either through an end-to-end anastomosis or lateral pancreaticojejunostomy. Both procedures are indicated in severe chronic pancreatitis with an enlarged pancreatic head.

Table 37.2 illustrates the salient differences between the operations employed to treat chronic pancreatitis.

Table 37.2 Comparison of various procedures for chronic pancreatitis [4, 6–8, 11, 12, 14, 16]

Procedure	Mortality	Endocrine insufficiency	Exocrine insufficiency	Pain relief	Fistula	Comments
Puestow procedure	<3%	Minimal	Unchanged	85%	2%	Recurrent pain occurs in 40–50% of patients within 5 years
Whipple procedure		40%	55%	85%	7%	
Distal pancreatectomy		35%	30%	60%	5%	
Frey procedure		<10%	15%	90%	3%	
Beger procedure		20%	20%	70%	<1%	

Table comparing the various procedures performed for chronic pancreatitis. Specifically, procedure related mortality, incidence of new-onset endocrine and exocrine dysfunction, pancreatic fistula, and pain relief were compared.

37.5 Positioning and Anesthesia

The patient is positioned supine on the operating table with arms extended. The level of intraoperative monitoring is dependent on the patient's general health status. All patients require adequate peripheral intravenous access, should the need for

rapid fluid replacement arise. Arterial monitoring is often performed to obtain real-time hemodynamic monitoring. Central venous cannulation should not be routinely employed, but reserved for patients whose peripheral intravenous access is inadequate or preexisting medical conditions, which require close attention to cardiac preload or fluid status.

General anesthesia and adequate muscle relaxation is required in all patients to facilitate exposure. Frequently, a self-retaining retractor system is employed. All patients should have a nasogastric tube placed for gastric decompression.

37.6 Description of the Procedure

Although several different operations for chronic pancreatitis exist, the Frey procedure, which combines a limited pancreatic head resection and a lateral pancreaticojejunostomy, will be described in detail here. The surgery can be divided into three parts: exposure and complete pancreatic evaluation, resection of pancreatic parenchyma facilitating pancreatic duct decompression, and construction of a Roux loop to drain the decompressed duct.

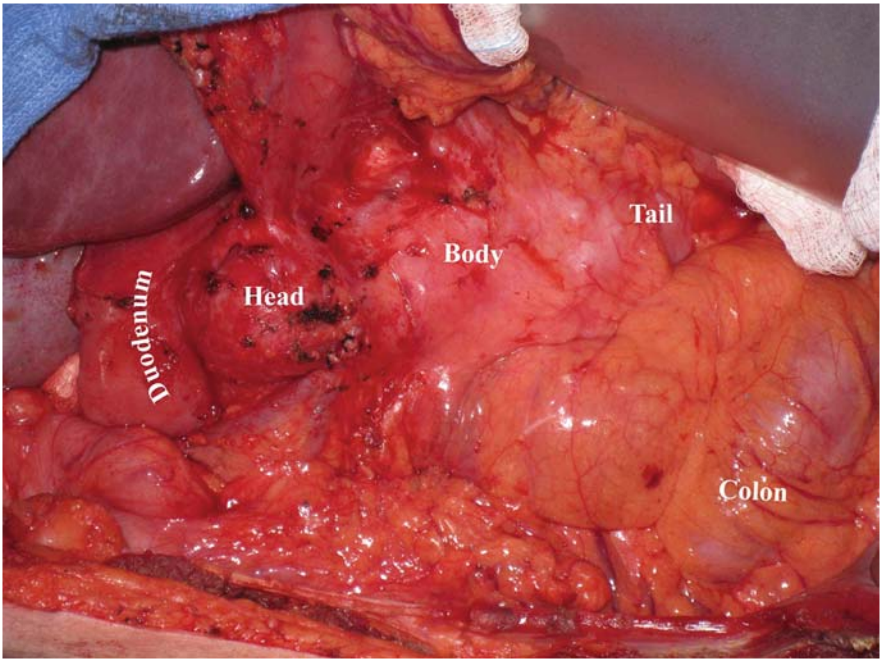

Fig. 37.3 Normal anatomy of the pancreas after entering the lesser sac

37.6.1 Exposing the Pancreas

A laparotomy is performed through a “Mercedes-Benz”, chevron, or midline incision. Access to the lesser sac is obtained through the gastrocolic ligament and the posterior attachments of the stomach are released (Fig. 37.3).

An extensive Kocher maneuver with hepatic flexure mobilization is performed to expose the pancreas. Once complete, the right gastroepiploic vein is divided close to its union with the middle colic vein. The right gastroepiploic artery is divided where it originates from the gastroduodenal artery on the anterior surface of the pancreas. The gastroduodenal artery, which runs from superior to inferior across the neck of the pancreas, is ligated above and below the planned line of incision in the pancreas. Using ultrasound guidance, a needle is navigated into the dilated pancreatic duct. Fine-tipped cautery is used to trace the path of the needle and enter the duct. The parenchyma overlying the duct is excised to unroof the dilated duct and permit adequate decompression (Fig. 37.4a–c).

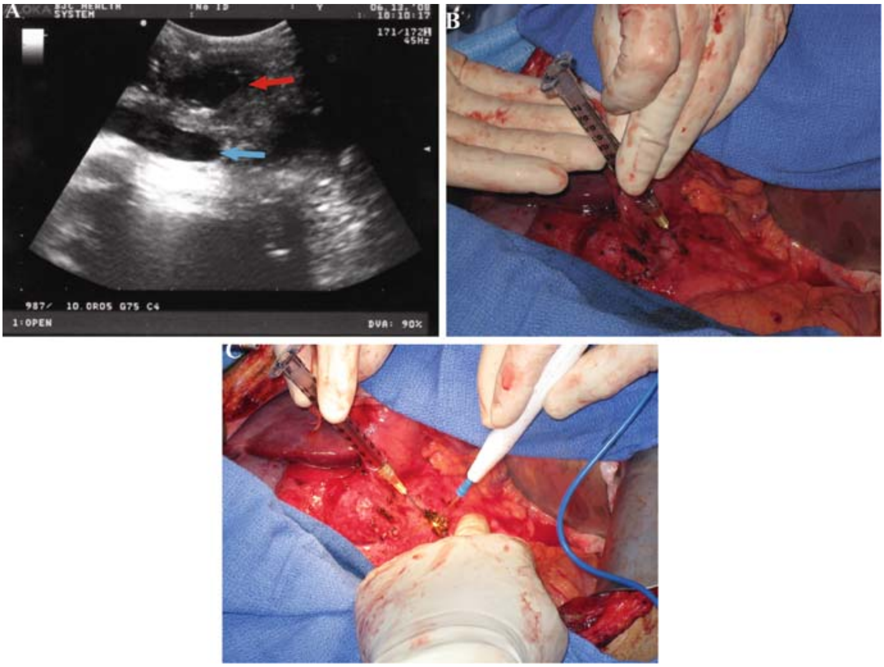

Fig. 37.4 Locating the pancreatic duct using ultrasound guidance and a syringe. (**a**) The *red arrow* indicates the dilated pancreatic duct and the *blue arrow* highlights the superior mesenteric vein. (**b**) Note the presence of pancreatic ductal hypertension as pancreatic fluid spontaneously decompresses into the syringe. (**c**) Bovie cautery is used to unroof the pancreatic duct

37.6.2 Resection of the Pancreatic Parenchyma

Resection of the overlying pancreatic tissue is required to facilitate decompression of the duct. Normally the duct in the body and tail is exposed first. A trough is created by resecting the overlying pancreatic tissue, with the pancreatic duct at the base. Enough pancreatic issue is left at the upper and lower borders of the pancreas to provide a margin to attach the Roux loop. Frequently, large pancreatic duct stones are encountered and are easily extracted.

To prepare for head coring, a series of 3-0 synthetic absorbable sutures is placed around the pancreatic head at the border of the duodenum to maintain hemostatic control during parenchymal resection. The incision in the pancreatic duct is carried into the head and all tissue anterior to the duct is excised in layers. Resection proceeds until approximately a thin, 1 cm margin of pancreas remains along posterior, lateral, superior, and inferior aspects. A biliary balloon catheter or sound is placed through the papilla into the duodenum to demonstrate unobstructed communication and to determine the right lateral resection margin (Fig. 37.5a–d). The surgeon must maintain awareness of the position of the portomesenteric veins and the posterior

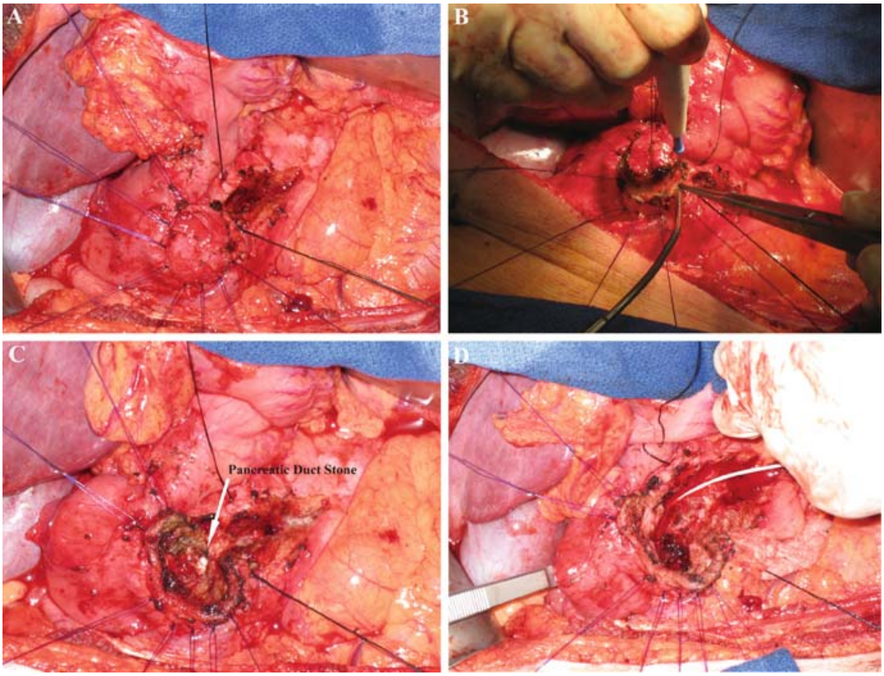

Fig. 37.5 Parenchymal resection. (**a**) Stay sutures are placed around the head of the pancreas to maintain hemostasis during resection. (**b**) The parenchyma is excised in layers. (**c**) A pancreatic duct stone is encountered in the remnant pancreatic duct. (**d**) After resection is complete, open communication between the duct and the duodenum is demonstrated by inserting a Fogarty catheter through the ampulla

surface of the pancreas, the latter by manual palpation of the mobilized duodenum. Excised tissue is sent for pathologic evaluation for occult pancreatic cancer.

37.6.3 Pancreaticojejunostomy

A Roux-en-Y pancreaticojejunostomy is used to drain the decompressed pancreatic duct. The Roux loop is created by transecting the small bowel approximately 20 cm distal to the ligament of Treitz. A functional end-to-end, side-to-side enteroenterostomy is created 60 cm downstream from the stapled end of the jejunum.

The free, stapled end of the jejunum is used to fashion the pancreaticojejunostomy (Fig. 37.6a–c). The Roux loop is brought into the lesser sac in a retrocolic fashion through a defect created in the mesocolon. Different methods of fashioning the side-to-side anastomosis have been described. In cases where the remaining pancreas is firm and can hold suture easily, the anastomosis is created using single-layer, running monofilament synthetic suture (3-0 polydioxanone,

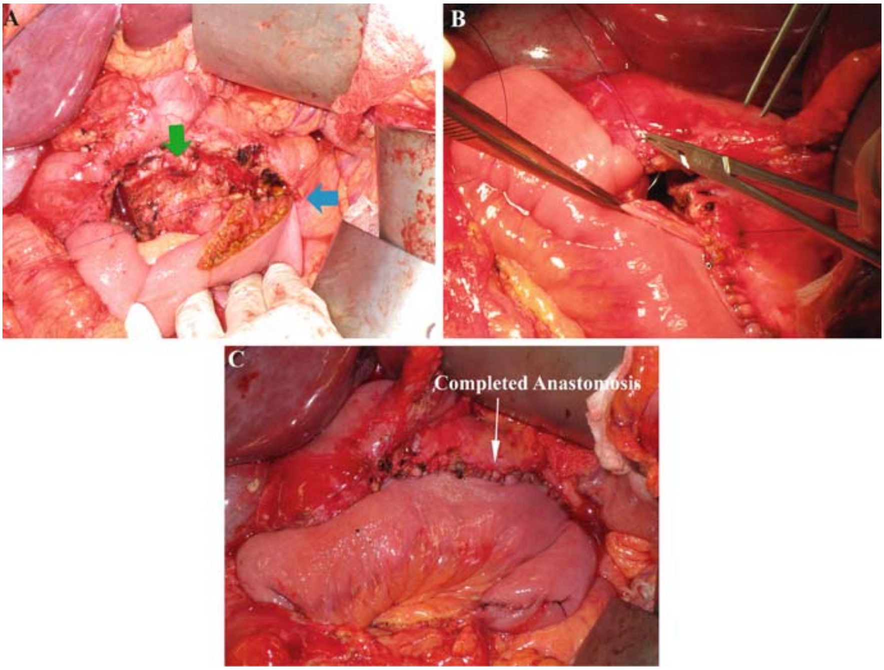

Fig. 37.6 Fashioning the pancreaticojejunostomy. (**a**) The small bowel enterotomy is considerably smaller than the length of the exposed duct, as the bowel wall is fairly elastic. The anastomosis is fashioned using a single layer of continuous running 3-0 polydioxanone (PDS) synthetic monofilament suture. The posterior anastomosis is created first (*blue arrow*; pancreatic duct, *green arrow*). (**b**) The superior aspect of the anastomosis is complete. (**c**) The finished pancreaticojejunostomy is shown

PDS). However, when the pancreas is soft, a two-layered closure can be performed with an inner layer of continuous monofilament suture and an outer layer of interrupted 3-0 silk sutures to anchor the small bowel to the surface of the pancreas.

After the anastomosis is completed, the defect in the mesocolon is approximated around the Roux loop. The field is thoroughly irrigated and hemostasis is confirmed. Closed suction drains are placed around the anastomosis before closing the abdomen.

37.7 Postoperative Care

Patients undergoing surgery for chronic pancreatitis require attentive care in the postoperative period, to assure optimal outcomes. Postoperative pain control can be difficult as many patients are dependent on narcotic pain medications. Epidural and patient-controlled analgesia are useful methods; the latter allows titration of pain medication to obtain adequate pain relief. All patients require monitoring for symptoms of alcohol withdrawal including autonomic instability (tachycardia, hypertension, and hyperthermia), insomnia, emotional irritability, and diaphoresis. Prophylaxis with benzodiazepines is indicated if symptoms of withdrawal of alcohol appear or alcohol dependence is suspected in order to prevent life-threatening complications such as delirium tremens and seizure.

The appearance of gland dysfunction may begin to present in the early postoperative period. Fasting blood glucose levels should be monitored; if needed, insulin replacement therapy and diabetic counseling are implemented. Patients should be monitored for malabsorption and steatorrhea. Malabsorption should be treated with pancreatic enzyme replacement (30,000 units of lipase with each meal). Restriction of dietary fat intake should improve steatorrhea.

Patients require routine follow up once discharged from the hospital. Recurrent pain should prompt a thorough evaluation, as the recurrence may herald the development of pancreatic cancer.

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Index

A
Abdominal wall hernias, 227–228
  indications, 227
  mesh materials, 228
    absorbable mesh, 228
    biologic absorbable mesh, 228
    permanent mesh, 228
    synthetic absorbable mesh, 228
  preoperative preparation, 227
Abdominoperineal resection (APR), 167–177
  anesthesia, 168
  in females, 170–171
  inferior mesenteric artery (IMA), 169
  in males, 170–171
  perineal portion of, 174
  perineal wound closing, 176
  positioning, 168
  posterior and lateral dissection, 175
  postoperative care, 176
  preoperative evaluation, 167–168
    physical examination, 168
  procedure, 169–171, 174
    abdominal phase of, 174
Achalasia, MIS treatment of, 81–86
  complications, 86
  fundoplication, 84–85
  hiatal and esophageal dissection, 82–83
    gastrohepatic ligament division, 82
  indications, 81
  laparoscopic Heller myotomy, 82
    anesthesia, 82
    positioning, 82
  myotomy, 83–84
  port placement, 82
  postoperative care, 86
  preoperative evaluation, 81–82
    esophageal manometry, 81
  procedure, description, 82–86
Adrenalectomy, 29–34
  See also Open adrenalectomy
Afferent loop syndrome, 123
Alkaline reflux gastritis, 122–123
ALND, *see* Axillary lymph node dissection (ALND)
Anal fissures, 189–193
  See also Lateral internal sphincterotomy
Anastomosis, in small bowel resection, 130
  hand-sewn anastomosis, 130–132
  stapled anastomoses, 131–132
Anorectal abscess, 195–199
  anesthesia, 196
  drainage, 196–199
    intersphincteric abscess, 198
    ischioanal abscess, 198
    perianal abscess, 198
    route, 198
    supralevator abscess, 198
  indications, 195
  locations of, 195–197
    intersphincteric, 195
    ischioanal, 195
    perianal, 195
    supralevator, 195
  normal anorectal anatomy, 196
  perioperative care, 195–196
    CT or MRI imaging studies, 195
    pre-procedure antibiotics, 195
  positioning, 196
  postoperative considerations, 199
  procedure, 196–199
Antecolic gastrojejunostomy, 308
Antrectomy for peptic ulcer, 114–116
  Billroth I reconstruction, 115
  Billroth II reconstruction, 115–116
  Billroth III reconstruction, 115–116
  duodenal ulcers, 115

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reconstruction method following, 115
upper midline incision, 114
Appendectomy, 139–145
indications, 139
peri-umbilical discomfort, 139
physical exam, 139
somatic pain, 139
open appendectomy, 141–142
preoperative preparation, 140
surgical approach, 140
See also Laparoscopic appendectomy
APR, *see* Abdominoperineal resection (APR)
Axillary dissection, 60
Axillary lymph node dissection (ALND), 57, 59–60
lateral-to-medial approach, 59
medial-to-lateral approach, 59
Axillary procedures, 57–60
axillary dissection, 60
axillary lymph node dissection, 59–60
blue lymphatics, 59
closure, 58
curvilinear incision, 58
Gamma probe, 58
modified radical mastectomy (MRM), 59
positioning, 58
S-shaped incision, 58

B

Bariatric surgery, 89
See also Laparoscopic Roux-en-Y gastric bypass
Beger procedure, 325
Belsey RH, 73
Bilateral neck exploration, 24–26
inferior parathyroids, 26
initial dissection for, 25
superior parathyroids, 25
Biliary procedures, 279–292
biliary-enteric reconstruction, 292
common bile duct exploration, 286–287
extrahepatic bile duct resection, 287–290
incision, 279
open cholecystectomy, 280–283
cystic artery, ligation and division, 282
portal lymphadenectomy, 290–291
See also Laparoscopic cholecystectomy
BIRADS score, 47, 48
Bleeding peptic ulcer, 111–112
Bloodless field need, in total thyroidectomy, 4
Blue lymphatics, 59
Breast
anatomy, 54
breast conserving therapy (BCT), 53
contraindications to, 53
procedures, 53–56
Breast biopsy, 47–52
BIRADS score, 47, 48
core biopsy, 50
diagnostic mammography, 47
excisional biopsy, 50–51
cosmesis, 51
harmonic scalpel use, 51
local anesthesia, 51
sedation in, 51
fine-needle aspiration, 50
methods, 47–52
needle-localized excisional biopsy, 51–52
non-palpable lesion, 48
palpable lesion, 48
stereotactic core biopsy, 48
ultrasound-guided core biopsy, 48

C

Central neck dissection, 11–15
ATA guidelines, 12
indications, 11–12
cervical nodal metastases, 11
lymph node metastases, 11
skip metastases, 11
left central neck dissection, 14–15
hemostasis, 14
lower parathyroid gland, devascularization, 14
position, 13
postoperative care, 15
preoperative preparation, 12–13
procedure, description, 13–15
central compartment lymph node dissection, 13
curvilinear incision, 13
lateral boundaries of the dissection, 13
medial boundaries of the dissection, 13
total thyroidectomy, 13
Cervical anastomosis, 106
Cervical nodal metastases, 11
Cholecystectomy, 253, 262–273
inflow control, 262–266
outflow control, 266
See also Parenchymal transection
Chronic gastric outlet obstruction due to peptic ulcer, 112–117
Finney pyloroplasty, 113
Heineke-Mikulicz pyloroplasty, 112–113
Jaboulay gastroduodenostomy, 113

pyloric obstruction, 112
pyloroplasty, 112–113
recalcitrant peptic ulcer disease, 113–114
resection for, 113–114
vagotomy for, 113–114
Chronic pancreatitis, surgical treatment, 321–330
anesthesia, 325–326
Beger procedure, 325
combined resection and drainage procedures, 325
distal pancreatectomy, 325
drainage procedures, 324
Frey procedure, 325
imaging studies, 322–323
ERCP, 323
MRCP, 323
indications, 322
pancreas, exposing, 327
pancreatic parenchyma, resection, 328–329
pancreaticojejunostomy, 329–330
positioning, 325–326
postoperative care, 330
preoperative preparation, 322–324
workup, 322
procedure, 326–330
selection, 323–324
Puestow procedure, 325
resection for chronic pancreatitis, 324
Whipple procedure, 325
Closed hemorrhoidectomy, 221–222
Closed sphincterotomy, 191
Collis gastroplasty, 77
Colostomy, 179–184
See also Stomas (colostomy and ileostomy)
Common bile duct exploration, 286–287
Cooper DS, 235–236
Core biopsy, 50
Cosmesis, 51
Crural closure, 68–69
Cryptoglandular disease, 195–205
See also Anorectal abscess; Fistula-in-ano
Curettage, 208

D

Deep vein thrombosis (DVT) prophylaxis, 90, 150, 160
Dexmedetomidine, 90
Direct laryngoscopy, 3
Distal pancreatectomy, 311–320, 325
anesthesia, 312
imaging studies, 311
laparoscopic distal pancreatectomy, 313–315
open distal pancreatectomy (RAMPS procedure), 312–313
positioning, 312
postoperative care, 315–320
mobilizing the inferior pancreas near the spleen, 316
pancreas in situ, 316
portosplenic confluence exposed, 318
splenic artery, identification, 318
stapling across the pancreas, 317
transected pancreas, 317
preoperative preparation, 311
procedure, 312–315
Duh QY, 40
Dumping syndrome, 122
Dysphagia, 71

E

Efferent limb syndrome, 123–124
Endorectal advancement flap, 203–204
Endoscopic ultrasound (EUS), 99
End-to-side sutured esophagojejunostomy, 121
Esophageal dissection, 82–83
Esophageal dysmotility, 81
Esophageal mobilization, 65–66
in laparoscopic paraesophageal hernia repair, 75–77
Esophagectomy, 99–107
Ivor-Lewis TTE approach, 100
minimally invasive esophagectomy (MIE), 100–107
See also individual entry
oncologic perspectives, 107
open esophagectomy, 100
transhiatal esophagectomy (THE), 100
transthoracic esophagectomy (TTE), 100
Excisional breast biopsy, 50–51
cosmesis, 51
harmonic scalpel use, 51
local anesthesia, 51
sedation in, 51
Extrahepatic bile duct resection, 287–290

F

Ferguson hemorrhoidectomy, 221
Fine-needle aspiration, 50
Finney pyloroplasty, 113
Fistula-in-ano, 199–205
anesthesia, 200
digital rectal examination, 200
endorectal advancement flap, 203–204
extrasphincteric, 199
fistulotomy, 201–202
fistulous tract, locating, 201

indications, 199
InStat placement, 201–202
intersphincteric, 199
location, 200
perioperative care, 199–200
positioning, 200
postoperative considerations, 205
preoperative preparation, 199–200
procedure, 200–205
seton placement, 202–203
cutting setons, 202
draining setons, 203
seton selection, 202
suprasphincteric, 199
surgical approaches, 204–205
anal fistula plug, 204–205
fibrin glue, 205
transsphincteric, 199
Fistulotomy, 208
Follicular cell cancer, 11
Frey procedure, 325
Fundoplication, 69–71, 84–85
See also Laparoscopic Nissen fundoplication

G

Gastric adenocarcinoma, 119–121
end-to-side sutured esophagojejunostomy, 121
indications, 119
lymphadenectomy, 119
D1, 119
D2, 119
D3, 119
preoperative evaluation, 119
subtotal gastrectomy, 119–120
total gastrectomy, 120–121
Gastric neoplasms, surgery for, 117–121
See also Gastric adenocarcinoma; Gastrointestinal stromal tumor (GIST)
Gastric pouch creation, Roux-en-Y gastric bypass, 93–95
Gastric resection, 109–124
afferent loop syndrome, 123
alkaline reflux gastritis, 122–123
complications, 121–124
dumping syndrome, 122
efferent limb syndrome, 123–124
postgastrectomy syndromes, 121–124
retained antrum, 124
See also Peptic ulcer disease
Gastroesophageal reflux disease (GERD), 63
Gastrointestinal stromal tumor (GIST), 117–119
indications, 117–118
preoperative evaluation, 117–118
resection of local disease, 118–119
Gastrojejunostomy, creation, 94
Gluteus maximus myocutaneous flap, 212–215
Graham patch closure, 110–111

H

Harmonic scalpel hemorrhoidectomy, 222
Hasson approach, 154
Heineke-Mikulicz pyloroplasty, 112
Heller myotomy, 82–85
Hemorrhoidectomy, 221–223
closed, 221–222
See also Open hemorrhoidectomy
Hemorrhoids, 217–223
acutely thrombosed external hemorrhoids, 217
anesthesia, 219
classification, 218
first degree, 218
fourth degree, 218
harmonic scalpel hemorrhoidectomy, 222
indications, 217
infrared photocoagulation, 220
internal hemorrhoids, 217
LigaSure hemorrhoidectomy, 222
perioperative care, 219
positioning, 219
postoperative considerations, 223
procedure, 220–223
rubber-band ligation, 220
sclerosis, 220
second degree, 218
stapled hemorrhoidopexy, 222–223
strangulated hemorrhoids, 217
symptoms, 218
third degree, 218
treatment of, 217
Whitehead's procedure, 223
Hepatic procedures, 249–277
exposure, 250–252
falciform ligament, division, 251
incision, 249–250
intraoperative hepatic ultrasonography, 251
oncological resections, 250
See also Left hemihepatectomy (Segmentectomy II, III, IV); Left lateral sectionectomy (Segmentectomy II, III); Right hemihepatectomy (Segmentectomy V-VIII)

Hepaticojejunostomy, 305
completing, 307
Hernias, 227–228
Roux-en-Y gastric bypass, 96
See also Abdominal wall hernias; Incisional hernia; Umbilical hernia
Hiatal and esophageal dissection, achalasia treatment, 82–83
gastrohepatic ligament division, 82
Hiatal dissection, 65–66
in laparoscopic paraesophageal hernia repair, 75–77
Hiatus hernias, 74
types, 74
type I ,74
type II, 74
type III, 74
type IV, 74
Hiatus, re-approximation of, 77–79
Hill LD, 73
Hook electrocautery, 75
Hürthle cell cancer, 11
Hyperthyroidism, 3

I
Ileocolic anastomosis, 152
Ileostomy, 179–184
See also Stomas (colostomy and ileostomy)
Incisional hernia, 239–240
laparoscopic repair of, 240
open repair of, 239–240
pneumoperitoneum, 240
suture-passing device, 240
Infrared photocoagulation, 220
Inguinal herniorrhaphy, 229–233
anesthesia, 229
Bassini repair, 229, 231
Ethicon Prolene Hernia System, 229
Lichtenstein repair, 229
McVey (Cooper's ligament) repair, 229
positioning, 229
procedure, 229
Shouldice repair, 229
See also Lichtenstein tension-free repair of inguinal hernia; Totally extraperitoneal preperitoneal (TEPP) laparoscopic inguinal hernia repair; Transabdominal preperitoneal (TAPP) technique
Intersphincteric abscess, 198
Intraoperative PTH monitoring (IOPTH), 28
Ischioanal abscess, 198

J
Jaboulay gastroduodenostomy, 112–113
Jejunojejunostomy mesenteric stomy defect, 92–93

K
Kocher transverse incision, total thyroidectomy, 4

L
Laparoscopic adrenalectomy, 37–44
indications, 37
left adrenalectomy, 41–42
plane between Gerota's fascia and pancreas, identification, 41
splenic flexure, mobilization, 41
port placement, 39–40
positioning, 39
decubitus positioning, 39
postoperative care, 43–44
adrenocortical cancer, 44
aldosterone-producing adenoma, 43
Cushing's syndrome, 43
pheochromocytoma, 44
preoperative preparation, 37–38
24-h urine cortisol and low-dose dexamethasone suppression test, 38
24-h urine metanephrines, 38
colonoscopy, 38
cross-sectional imaging (CT or MRI), 38
CXR, 38
dehydroepiandrosterone, 38
estradiol, 38
free testosterone, 38
history, 37
mammogram, 38
octreotide scan, 38
physical examination, 37
plasma aldosterone and renin, 38
urinary 5-HIAA, 38
procedure, description, 38–43
adrenal gland separation from superior pole of kidney, 40
adrenal vein, identifying and ligating, 40
opening the book, 40
periadrenal attachments, freeing, 40
reading from the top down, 40
retroperitoneal approach, 38
right adrenalectomy, 42–43
transabdominal approach, 38
See also Open adrenalectomy

Laparoscopic appendectomy, 142–144
 blunt dissection, 142
 open Hasson technique, 142
 pneumoperitoneum, 143, 144
 postoperative care, 145
 preoperative preparation, 142
Laparoscopic-assisted right hemicolectomy, 154–156
 Hasson approach, 154
 lateral-to-medial or medial-to-lateral approach, 154
Laparoscopic-assisted sigmoidectomy, 162–165
 lateral-to-medial approach, 163
 purse-string suture, 165
 suprapubic transverse or vertical periumbilical incision, 165
 white line of Toldt, 164
Laparoscopic cholecystectomy, 283–286
 gallbladder dissection, 285–286
Laparoscopic distal pancreatectomy, 313–315
Laparoscopic gastric mobilization, 103–106
Laparoscopic Heller myotomy, 82–85
Laparoscopic Nissen fundoplication, 63–71
 anesthesia, 64–71
 complications, 71
  dysphagia, 71
 esophageal mobilization, 65–66
 esophagus, mobilization, 68
  crural closure, 68–69
  Penrose drain, 68
 fundus mobilization, 66–68
 hiatal dissection, 65–66
 indications, 63
 port placement, 64–65
  location for, 65
 positioning, 64–71
 postoperative care, 71
 preoperative evaluation, 64
 procedure, description, 64–71
 right crural dissection, 66
 short gastric arteries, division, 66–68
Laparoscopic paraesophageal hernia repair, 73–80
 anesthesia, 75
 basic principles, 75
  re-approximation of the hiatus, 75
  subdiaphragmatic anchoring of the stomach, 75
  tension-free reduction of stomach and esophagus into the abdomen, 75
 classification, 74
 Collis gastroplasty, 77
 esophageal mobilization, 75–77
 hiatal dissection, 75–77
 indications, 73
 port placement, 75
 positioning, 75
 postoperative care, 79
 preoperative evaluation, 74–75
  paraesophageal hernia patient, 74
 primary crural repair, 78
 procedure, description, 75–79
 re-approximation of hiatus, 77–79
 short esophagus, 77
 subdiaphragmatic anchoring of stomach, 79
 transabdominal approach, 76
Laparoscopic repair of incisional hernias, 240
Laparoscopic Roux-en-Y gastric bypass, 89–97
 anesthesia, 90
 complications, 97
 deep venous thromboembolism (DVT), 90
 gastric pouch, creation, 93–95
  Nathanson retractor insertion, 93
  transgastric placement of anvil, 94
 gastrojejunostomy, creation, 94
 indications, 89
 intraoperative considerations, 95–96
  gallbladder, 95–96
  hernias, 96
  severe obesity, 96
 jejunojejunostomy, 92
 port placement, 91–92
 positioning, 90
  arms, 90
 postoperative care, 96–97
 preoperative evaluation, 90
 procedure, description, 91–95
 pulmonary embolism, 90
 Roux-limb, creation, 92–93
  Treitz ligament, identification, 92
Laparoscopic splenectomy, 293–295
LAR, *see* Low anterior resection (LAR)
Lateral internal sphincterotomy (LIS), 189–193
 anesthesia, 190
 closed, 191–192
 open, 191–192
 positioning, 190
  pronejackknife position, 190
 postoperative considerations, 193
 preoperative care, 189–190
 procedure, 191
  electrocautery, 192
Lateral mini-incision technique, 27

Left adrenalectomy, 41–42
See also under Laparoscopic adrenalectomy
Left hemihepatectomy (Segmentectomy II, III, IV), 262
exposure, 262
Left lateral sectionectomy (Segmentectomy II, III), 273–277
exposure, 273–274
inflow control, 274–275
parenchymal transection, 275–277
Left-sided adrenalectomy, 31–34
See also under Open adrenalectomy
Lewis JJ, 100
Lichtenstein tension-free repair of inguinal hernia, 230–233
direct hernia, 231
indirect hernia, 231
obtaining exposure, 230
open repair of left inguinal hernia, 230
repair the hernial defect, 231
LigaSure hemorrhoidectomy, 222
LIS, *see* Lateral internal sphincterotomy (LIS)
Low anterior resection (LAR), 167–177
anesthesia, 168
anvil insertion, 173
double-stapled anastomosis, 172
end-to-end anastomosis, 171
in females, 170–171
inferior mesenteric artery (IMA), 169
J-pouch, 173
in males, 170–171
positioning, 168
preoperative evaluation, 167–168
physical examination, 168
procedure, 169–171
Lower esophageal sphincter (LES), 81
Lugol's solution, 3
Luketich JD, 103
Lymph node metastases, 11
Lymphazurin (isosulfan blue), 57
Lymphoscintigraphy, 58

M
Marsupialization, 208–209
Mastectomy
partial, 54–55
simple/total mastectomy, 55–56
skin-sparing, 55–56
McKeown approach, 101
Meckel's diverticulum resection, 135–138
bleeding due to, 136
imaging studies, 135–136
indications, 135
postoperative care, 138
preoperative preparation, 135–136
procedure, 137
simple diverticulectomy, 137
surgical approach, 136
laparoscopic, 136
^{99}Technetium sulfur colloid nuclear medicine scan (Meckel's scan), 136
V-shaped incision, 137
Medial dissection, modified radical neck dissection, 21
Mesenteric defect, 92–93
Mesh materials for hernias, 228
See also under Abdominal wall hernias
Minimally invasive esophagectomy (MIE), 100–107
cervical anastomosis, 106
indications, 100–101
laparoscopic gastric mobilization and conduit preparation, 103–106
patient position, 103
port sites, 103–104
pyloroplasty, 104
steep reverse Trendelenburg positioning, 103
thoracoscopic esophageal mobilization, 101–103
anastomosis, 102–103
McKeown approach, 101
Penrose drain, 102
Minimally invasive parathyroidectomy (MIP), 27–28
direct view central miniincision, 27
direct view lateral mini-incision, 27
intraoperative PTH monitoring (IOPTH), 28
lateral mini-incision technique, 27
video-assisted, 27
videoscopic, 27
Minimally invasive surgical (MIS) treatment of achalasia, 81–86
See also Achalasia
Modified radical mastectomy (MRM), 59
Modified radical neck dissection (MRND), 17–22
indications, 17–18
medial dissection, 21
postoperative care, 21–22
laryngoscopy, 21
preoperative preparation, 18
procedure, description, 18–21
levels II and III, 19

levels IV and VB, 19–20
neck, 18–19
skin incisions, 19
prophylactic MRND, 18
right MRND, 20
therapeutic MRND, 18
Myotomy, 83–84

N

Neck dissection, 11–15
See also Central neck dissection
Needle-localized excisional biopsy, 51–52
needle localization, 52
Nuclear medicine scan (Meckel's scan), 136

O

Obesity consideration, Roux-en-Y gastric bypass, 96
Open adrenalectomy, 29–34, 141–142
indications, 29
left-sided adrenalectomy, 31–34
adrenal vein, identification, ligation, division, 32
lienorenal ligament, division, 32–33
spleen and tail of pancreas, medialization, 32–33
subcostal incision, 31
positioning, 30
lateral, 30
procedure, description, 30–34
postoperative care, 34
preoperative preparation, 29–30
DVT prophylaxis, 30
right-sided adrenalectomy, 30–31
costal incision, 30–31
subcostal incision, 31
See also Laparoscopic adrenalectomy
Open cholecystectomy, 280–283
Open distal pancreatectomy (RAMPS procedure), 312–313
Open esophagectomy, 100
Open hemorrhoidectomy, 221–222
combined internal–external hemorrhoid, 221
electrocautery, 221
gauze dressing, 221
Open repair of incisional hernias, 239–240
Open resection, small bowel, 128
Open right hemicolectomy, 150–154
hepatic flexure, mobilization around, 151
ileocolic anastomosis, 152
self-retaining retractor use in, 150
small bowel mesentery, 152
stapled side-to-side anastomosis, 153–154
Open sigmoidectomy, 160–162
double-stapled anastomosis, 162
sigmoid colon, mobilization, 161
skin incision, 160
transection, 162
rectosigmoid junction, 162
Open sphincterotomy, 191
Ostomy, 179
maturing process, 183
See also Stomas (colostomy and ileostomy)

P

Pancreatic parenchyma, resection, 328–329
Pancreaticoduodenectomy (Whipple procedure), 299–309
anatomic relationships following, 306
anesthesia, 300
antecolic gastrojejunostomy, 308
common bile duct, identification and division, 304
initial dissection, 301
kocherization, 301
performing, 308
perioperative care, 299–300
positioning, 300
postoperative considerations, 309
procedure, 300–308
pylorus-preserving pancreaticoduodenectomy, 309
subpancreatic tunnel, development, 302
upper jejunum, mobilization, 305
Pancreaticojejunostomy, 329–330
Papillary cell cancer, 11
Paraesophageal hernias, 73–80
See also Laparoscopic paraesophageal hernia repair
Parathyroidectomy, 23–28
anesthesia, 24
positioning, 24
postoperative care, 28
preoperative preparation
imaging studies, 24
parathyroid ultrasound, 24
^{99m}Tc-sestamibi scan, 24
procedure, description, 24–28
bilateral neck exploration, 24–26, *See also individual entry*
minimally invasive parathyroidectomy (MIP), 27–28, *See also individual entry*

Parenchymal transection, 258–261, 269–273, 275–277
  Glisson's capsule, division, 259
  middle hepatic vein, division, 261
Parks hemorrhoidectomy, 221
Partial mastectomy, 54–55
Peptic ulcer disease, 109–117
  antrectomy for, 114–116
    duodenal ulcers, 115
    upper midline incision, 114
  bleeding peptic ulcer, 111–112
  chronic gastric outlet obstruction due to, 112–117
    See also individual entry
  evaluation, 109–117
  Heineke-Mikulicz pyloroplasty, 112
  intraoperative cholangiography, 112
  perforated peptic ulcer, 110–111
    Graham patch closure, 110
  surgical indications, 109–117
  vagotomy, 116–117
    bilateral truncal vagotomy, 116
Perforated peptic ulcer, 110–111
Perianal abscess, 198
Pilonidal operations, 207–215
  anesthesia, 208
  cleft closure, 210
  curettage, 208
  debridement to sacral fascia, 214
  excision and primary closure, 209
  fistulotomy, 208
  gluteus maximus myocutaneous flap, 212–215
  indications, 207
  marsupialization, 208–209
    completed, 215
    with interrupted suture, 215
  perioperative care, 208
  positioning, 208
  preoperative positioning, 214
  procedures, 208–215
  rhomboid flap, 211–212
  sinus tract with probe, identification, 214
  treatment methods, comparison, 207
  V-Y advancement flap, 210–211
  Z-plasty, 210
Pneumoperitoneum, 82, 240
Port placement, laparoscopic adrenalectomy, 39–40
Portal lymphadenectomy, 290–291
Prophylactic MRND, 18
Puestow procedure, 325
Pyloric obstruction due to peptic ulcer, 112
Pyloroplasty, 112–113
Pylorus-preserving pancreaticoduodenectomy, 309
Pyramidal lobe mobilization, total thyroidectomy, 8

R

Radical neck dissection, 17–22
  See also Modified radical neck dissection (MRND)
Recalcitrant peptic ulcer disease, 113–114
Repair hernial defect, 236
Retained antrum, 124
Retroperitoneal approach, in laparoscopic adrenalectomy, 38
Rhomboid flap, 211–212
Right adrenalectomy, 42–43
Right hemicolectomy, 149–156
  anesthesia, 150
  indications, 149
  positioning, 150
  postoperative care, 156
  preoperative preparation, 150
  procedure, 150–156
  See also Laparoscopic-assisted right hemicolectomy; Open right hemicolectomy
Right hemihepatectomy (Segmentectomy V-VIII), 252–261
  cholecystectomy, 253
  exposure, 252
  inflow control, 253–256
  outflow control, 256–258
  parenchymal transection, 258–261
  right hepatic artery, division, 254
Right-sided adrenalectomy, 30–31
Roux-en-Y gastric bypass, *see* Laparoscopic Roux-en-Y gastric bypass
Roux-en-Y pancreaticojejunostomy, 329
Rubber-band ligation, 220

S

Sclerosis, 220
Sentinel lymph node biopsy (SLNB), 57
Seton placement, fistula-in-ano, 202–203
  See also under Fistula-in-ano
Short esophagus, 77
Sidhu, SB, 29
Sigmoid colectomy, 159–165
  anesthesia, 159–160
    general endotracheal, 159
  indications, 159
  positioning, 159–160
  postoperative care, 165

preoperative preparation, 159
procedure, 160–165
See also Laparoscopic-assisted sigmoidectomy; Open Sigmoidectomy
Simple diverticulectomy, 137
Simple/total mastectomy, 55–56
Skin incision, total thyroidectomy, 4
Skin-sparing mastectomy, 55–56
Skip metastases, 11
Small bowel resection, 127–133
anesthesia, 127–128
laparoscopic approach, 132
open resection, 128
positioning, 127–128
intravenous paralytics, 127
supine, 128
postoperative care, 133
preoperative preparation, 127
procedure, description, 128–133
anastomosis, 130–133
hand-sewn anastomosis, 130–131
intestine division, 129
mesentery, 129
Sphincterotomy, 189–193
See also Lateral internal sphincterotomy (LIS)
Splenectomy, 120
Stapled hemorrhoidopexy, 222–223
Stereotactic core biopsy, 48
Stomas (colostomy and ileostomy), 179–184
anesthesia, 180
ostomy maturing process, 183
positioning, 180
postoperative care, 184
preoperative preparation, 180
counseling, 180
procedure, 180–184
adipose, excision, 182
Babcock clamp in, 181
blunt retractors in, 181
circular skin disk, excision, 181
electrocautery, 181
rectus sheath division, 182
Subdiaphragmatic anchoring, 79
Subtotal gastrectomy, 119–120
Supralevator abscess, 198

T
^{99}Technetium sulfur colloid nuclear medicine scan (Meckel's scan), 136
Therapeutic MRND, 18
Thyroid lobectomy, 3–8
preoperative preparation, 3
procedure, description, 4–8
isthmus division, 5
lateral and inferior aspects of thyroid lobe, mobilization, 6
Thyroidectomy, 3–8
indications for, 3
goiters with or without local compressive symptoms, 3
hyperthyroidism, 3
thyroid nodules and cancers, 3
See also Total thyroidectomy
Total gastrectomy, 120–121
Total thyroidectomy, 3–8
anesthesia, 4
positioning, 4
head, 4
neck, 4
postoperative care, 8
neck hematoma, 8
oral calcium supplements, 8
preoperative preparation, 3
antithyroid medication, 3
direct laryngoscopy, 3
Lugol's solution, 3
procedure, description, 4–8
bloodless field, need for, 4
IPT, identification, 7
Kocher transverse incision, 4
MTV, identification, 5
pyramidal lobe, mobilization, 8
RLN, identification, 7
SPT, identification, 7
sternothyroid muscle, dissection, 5
strap muscles, separation, 5
superior pole, dissection, 6–7
Totally extraperitoneal preperitoneal (TEPP) laparoscopic inguinal hernia repair, 229–233, 235–238
anatomy, exposing, 235
closure, 238
gain entry to preperitoneal space, 235
hernia reduction, 235
left inguinal area with, anatomy, 236–237
repair hernial defect, 236
Transabdominal approach, in laparoscopic adrenalectomy, 38
Transabdominal preperitoneal (TAPP) technique, 229, 235–238
Transhiatal esophagectomy (THE), 100

Transthoracic esophagectomy (TTE), 100, 101–103
True paraesophageal hernia, 74
Truncal vagotomy, 116
Tubercle of Zuckerkandl (TOZ), 6–7, 25

U
Ultrasound-guided core biopsy, 48–50
Umbilical hernia, 243–244
  closure of fascial defect, 244
  dissection of hernia contents, 244
  incision, 243

V
Vagotomy, 116–117
  bilateral truncal vagotomy, 116
V-Y advancement flap, 210–211

W
Whipple procedure, 299–309, 325

X
Young WF, 29

Z
Z-plasty, 210